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MAINTENANCE INTERVALS

Operation and Maintenance
Manual Excerpt

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SEBU7563-09
April 2010

Operation and Maintenance Manual

G3600 Engines

BLB1-Up (Engine)
BKE1-Up (Engine)
BEN1-Up (Engine)
4ZS1-Up (Engine)

i03915129

Maintenance Interval Schedule (G3600 Engines That Use Wellhead or Natural Gas and Have a Compression Ratio of 9.2:1)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of all maintenance including the following procedures: all adjustments, the use of proper lubricants, fluids, filters, and the installation of new components due to normal wear and aging . The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Note: Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, service hours, and calendar time . Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Products that operate in severe operating conditions may require more frequent maintenance.

When Required

Actuator Control Linkage - Replace 66
Barring Device - Lubricate 69
Cooling System Coolant Sample (Level 2) - Obtain 77
Engine Air Cleaner Element (Single Element) - Clean/Replace 87
Engine Air Precleaner - Clean 91
Overhaul Considerations 116
Valve Stem Projection - Measure/Record 122

Daily

Air Starting Motor Lubricator Oil Level - Check 68
Air Tank Moisture and Sediment - Drain 69
Control Panel - Inspect 74
Cooling System Coolant Level - Check 76
Driven Equipment - Inspect/Replace/Lubricate ... 83
Electrohydraulic System - Inspect 86
Engine Oil Level - Check 96
Fuel System Fuel Filter Differential Pressure - Check 103
Walk-Around Inspection 123

Every 250 Service Hours

Battery Electrolyte Level - Check 71
Cooling System Coolant Sample (Level 1) - Obtain 77
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 78
Engine Oil Sample - Obtain 97

Initial 1000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Electrohydraulic System Oil Filter - Change 87
Engine Crankcase Breather - Clean 91
Engine Protective Device Connections - Inspect .. 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 1000 Service Hours

Actuator Control Linkage - Lubricate 66
Belts - Inspect/Adjust/Replace 71
Hoses and Clamps - Inspect/Replace 105
Ignition System Spark Plugs - Check/Adjust 108

Every 2000 Service Hours

Aftercooler Condensation - Drain 67
Cooling System Coolant Sample (Level 2) - Obtain 77
Crankshaft Vibration Damper - Inspect 80
Engine Crankcase Breather - Clean 91
Engine Mounts - Check 92
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 5000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Combustion Sensor - Clean/Inspect/Replace 72
Cooling System Level Switch - Inspect 77
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Driven Equipment - Check 82
Electrohydraulic System - Check/Adjust 85
Electrohydraulic System Oil - Change 86
Electrohydraulic System Oil Filter - Change 87
Engine Oil - Change 92
Engine Oil Filter - Change 93
Engine Protective Device Connections - Inspect .. 98
Engine Protective Devices - Check 100
Exhaust Bypass - Recondition 102
Gas Shutoff Valve - Inspect 105
Ignition System Spark Plugs - Replace 111
Inlet Air System - Inspect 111

Inlet Gas Manifold and Piping - Inspect/Replace .. 111
Prechamber Check Valves - Clean 118
Starting Motor - Inspect 119
Turbocharger - Inspect 121

Every 10 000 Service Hours

Alternator - Inspect 69
Cooling System Water Temperature Regulator - Replace 79
Electrohydraulic Actuator - Inspect 83
Engine Oil Temperature Regulator - Replace 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Exhaust Shields - Inspect 102
Gas Pressure Regulator - Inspect/Replace 104
Prechamber Check Valves - Replace 119
Prelube Pump - Inspect 119
Water Pump - Inspect 124

Every 20 000 Service Hours or 3 Years

Cooling System Coolant (NGEC) - Change 74

Every 25 000 Service Hours

Gas Admission Valve Seals - Inspect/Replace ... 104
Overhaul (Top End) 114
Prechamber - Clean/Inspect 118

Every 50 000 Service Hours

Electrohydraulic Actuator - Recondition 84
Gas Admission Valve - Recondition 103
Overhaul (In-Frame) 112

Every 100 000 Service Hours

Overhaul (Major) 113

i03915106

Maintenance Interval Schedule (G3600 Engines That Use Natural Gas and Have a Compression Ratio of 10.5:1 or 11:1)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of all maintenance including the following procedures: all adjustments, the use of proper lubricants, fluids, filters, and the installation of new components due to normal wear and aging . The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Note: Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, service hours, and calendar time . Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Products that operate in severe operating conditions may require more frequent maintenance.

When Required

Actuator Control Linkage - Replace 66
Barring Device - Lubricate 69
Cooling System Coolant Sample (Level 2) - Obtain 77
Engine Air Cleaner Element (Single Element) - Clean/Replace 87
Engine Air Precleaner - Clean 91
Overhaul Considerations 116
Valve Stem Projection - Measure/Record 122

Daily

Air Starting Motor Lubricator Oil Level - Check 68
Air Tank Moisture and Sediment - Drain 69
Control Panel - Inspect 74
Cooling System Coolant Level - Check 76
Driven Equipment - Inspect/Replace/Lubricate ... 83
Electrohydraulic System - Inspect 86
Engine Oil Level - Check 96
Fuel System Fuel Filter Differential Pressure - Check 103
Walk-Around Inspection 123

Every 250 Service Hours

Battery Electrolyte Level - Check 71
Cooling System Coolant Sample (Level 1) - Obtain 77
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 78
Engine Oil Sample - Obtain 97

Initial 1000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Electrohydraulic System Oil Filter - Change 87
Engine Crankcase Breather - Clean 91
Engine Protective Device Connections - Inspect .. 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 1000 Service Hours

Actuator Control Linkage - Lubricate 66
Belts - Inspect/Adjust/Replace 71
Hoses and Clamps - Inspect/Replace 105
Ignition System Spark Plugs - Replace 111

Every 2000 Service Hours

Aftercooler Condensation - Drain 67
Cooling System Coolant Sample (Level 2) - Obtain 77
Crankshaft Vibration Damper - Inspect 80
Engine Crankcase Breather - Clean 91
Engine Mounts - Check 92
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 5000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Combustion Sensor - Clean/Inspect/Replace 72
Cooling System Level Switch - Inspect 77
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Driven Equipment - Check 82
Electrohydraulic System - Check/Adjust 85
Electrohydraulic System Oil - Change 86
Electrohydraulic System Oil Filter - Change 87
Engine Oil - Change 92
Engine Oil Filter - Change 93
Engine Protective Device Connections - Inspect .. 98
Engine Protective Devices - Check 100
Exhaust Bypass - Recondition 102
Gas Shutoff Valve - Inspect 105
Inlet Air System - Inspect 111
Inlet Gas Manifold and Piping - Inspect/Replace .. 111

Prechamber Check Valves - Clean 118
Starting Motor - Inspect 119
Turbocharger - Inspect 121

Every 10 000 Service Hours

Alternator - Inspect 69
Cooling System Water Temperature Regulator - Replace 79
Electrohydraulic Actuator - Inspect 83
Engine Oil Temperature Regulator - Replace 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Exhaust Shields - Inspect 102
Gas Pressure Regulator - Inspect/Replace 104
Prechamber Check Valves - Replace 119
Prelube Pump - Inspect 119
Water Pump - Inspect 124

Every 15 000 Service Hours

Gas Admission Valve Seals - Inspect/Replace ... 104
Overhaul (Top End) 114
Prechamber - Clean/Inspect 118

Every 20 000 Service Hours or 3 Years

Cooling System Coolant (NGEC) - Change 74

Between 45 000 and 48 000 Service Hours

Electrohydraulic Actuator - Recondition 84
Gas Admission Valve - Recondition 103
Overhaul (In-Frame) 112

Between 75 000 and 80 000 Service Hours

Overhaul (Major) 113

i03915101

Maintenance Interval Schedule (G3600 Engines That use Bio-Gas)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of all maintenance including the following procedures: all adjustments, the use of proper lubricants, fluids, filters, and the installation of new components due to normal wear and aging . The performance of this product may be diminished if proper maintenance intervals and procedures are not followed. Components may experience accelerated wear if proper maintenance intervals and procedures are not followed.

Note: Use whichever of the following that occurs first in order to determine the maintenance intervals: fuel consumption, service hours, and calendar time . Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Products that operate in severe operating conditions may require more frequent maintenance.

When Required

Actuator Control Linkage - Replace 66
Barring Device - Lubricate 69
Cooling System Coolant Sample (Level 2) - Obtain 77
Engine Air Cleaner Element (Single Element) - Clean/Replace 87
Engine Air Precleaner - Clean 91
Engine Oil - Change 92
Engine Oil Filter - Change 93
Overhaul Considerations 116
Valve Stem Projection - Measure/Record 122

Daily

Air Starting Motor Lubricator Oil Level - Check 68
Air Tank Moisture and Sediment - Drain 69
Control Panel - Inspect 74
Cooling System Coolant Level - Check 76
Driven Equipment - Inspect/Replace/Lubricate ... 83
Electrohydraulic System - Inspect 86
Engine Air Cleaner Service Indicator - Inspect 90
Engine Oil Level - Check 96
Fuel System Fuel Filter Differential Pressure - Check 103
Turbocharger - Clean 120
Walk-Around Inspection 123

Every 125 Service Hours

Engine Oil Sample - Obtain 97

Every 250 Service Hours

Battery Electrolyte Level - Check 71
Cooling System Coolant Sample (Level 1) - Obtain 77
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 78

Initial 1000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Electrohydraulic System Oil Filter - Change 87
Engine Crankcase Breather - Clean 91
Engine Protective Device Connections - Inspect .. 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 1000 Service Hours

Actuator Control Linkage - Lubricate 66
Belts - Inspect/Adjust/Replace 71
Combustion Sensor - Clean/Inspect/Replace 72
Hoses and Clamps - Inspect/Replace 105
Ignition System Spark Plugs - Replace 111
Prechamber Check Valves - Clean 118

Every 2000 Service Hours

Aftercooler Condensation - Drain 67
Cooling System Coolant Sample (Level 2) - Obtain 77
Crankshaft Vibration Damper - Inspect 80
Cylinders - Inspect 82
Engine Crankcase Breather - Clean 91
Engine Mounts - Check 92
Engine Valve Lash - Inspect/Adjust 101
Engine Valve Rotators - Inspect 102
Valve Stem Projection - Measure/Record 122

Every 5000 Service Hours

Air Starting Motor Lines Screen - Clean 67
Air Starting Motor Lubricator Bowl - Clean 67
Cooling System Level Switch - Inspect 77
Crankcase Blowby - Measure/Record 80
Cylinder Pressure - Measure/Record 81
Driven Equipment - Check 82
Electrohydraulic System - Check/Adjust 85
Electrohydraulic System Oil - Change 86
Electrohydraulic System Oil Filter - Change 87
Engine Protective Device Connections - Inspect .. 98
Engine Protective Devices - Check 100
Exhaust Bypass - Recondition 102
Gas Shutoff Valve - Inspect 105

Inlet Air System - Inspect 111
Inlet Gas Manifold and Piping - Inspect/Replace .. 111
Prechamber Check Valves - Replace 119
Starting Motor - Inspect 119
Turbocharger - Inspect 121
Turbocharger Cleaner Tube - Replace 122

Between 10 000 and 14 000 Service Hours

Gas Admission Valve Seals - Inspect/Replace ... 104
Overhaul (Top End) 114
Prechamber - Clean/Inspect 118

Every 10 000 Service Hours

Alternator - Inspect 69
Cooling System Water Temperature Regulator - Replace 79
Electrohydraulic Actuator - Inspect 83
Engine Oil Temperature Regulator - Replace 98
Engine Speed/Timing Sensor - Clean/Inspect 100
Exhaust Shields - Inspect 102
Gas Pressure Regulator - Inspect/Replace 104
Prelube Pump - Inspect 119
Water Pump - Inspect 124

Every 20 000 Service Hours or 3 Years

Cooling System Coolant (NGEC) - Change 74

Between 27 000 and 33 000 Service Hours

Electrohydraulic Actuator - Recondition 84
Gas Admission Valve - Recondition 103
Overhaul (In-Frame) 112

Between 36 000 and 44 000 Service Hours

Gas Admission Valve Seals - Inspect/Replace ... 104
Overhaul (Top End) 114

Between 52 000 and 54 000 Service Hours

Overhaul (Major) 113

i02601608

Actuator Control Linkage - Lubricate (If applicable)

SMCS Code: 1265-086

WARNING

The linkage can move and form a pinch point which can cause personal injury. Keep hands away from the linkage.

Before performing this procedure, ensure that the linkage is meant to be lubricated. If the linkage is meant to be lubricated, this article applies to the following: air choke actuator, fuel control actuator, and exhaust bypass actuator.

Apply Dow Corning 41 Extreme High Temperature Bearing Grease to the rod ends (bearings) of the control linkage for the actuator. For more information on grease, see the Special Publication, SEBU6400, “Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations”.

Note: The exhaust heat shields must be in place and snug around the shaft of the wastegate in order to provide maximum life of rod ends.

Hydraulic Actuators

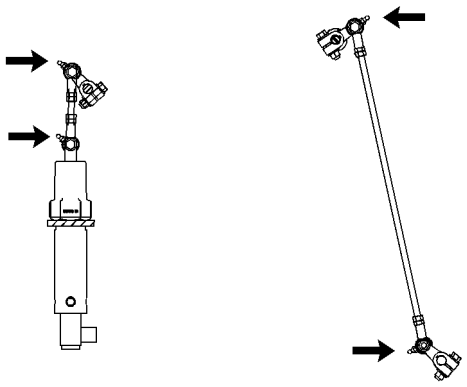


Illustration 41 g01120800

Typical locations of grease fittings

i02236400

Actuator Control Linkage - Replace

SMCS Code: 1265-510

Inspect the rod ends of the following components for wear:

Note: Use of a platform may be necessary to reach the linkages.

- Air choke actuator
- Exhaust bypass actuator
- Fuel control actuator
- Linkages

If necessary, replace the rod ends.

Removal and Installation

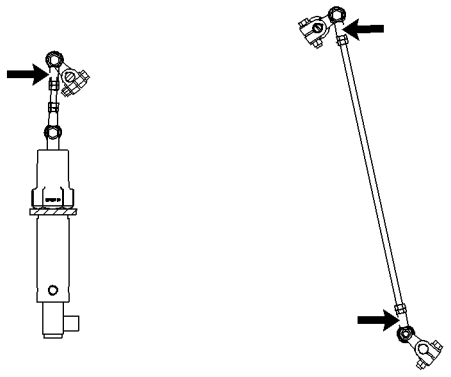


Illustration 42 g00799207

Typical example of rod ends on an actuator and on the linkage for an actuator

For instructions on removal and installation of the control linkage for the actuators, see the Disassembly and Assembly Manual. See the Specifications Manual for instructions on adjusting the actuators. Consult your Caterpillar dealer for assistance.

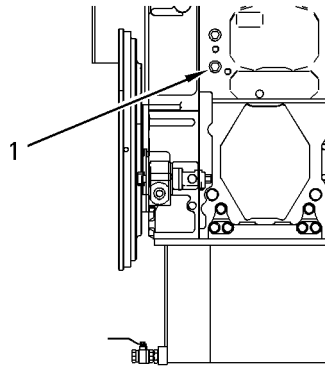
i01762572

Aftercooler Condensation - Drain

SMCS Code: 1063

The aftercooler is similar to a radiator. Coolant passes through the tubes in the aftercooler core. Inlet air that is warmed by the turbocharger compressor is directed through the aftercooler core. The air is cooled in the aftercooler.

Condensation can form in the passages of the aftercooler system. Drain plugs are provided for draining the condensation.

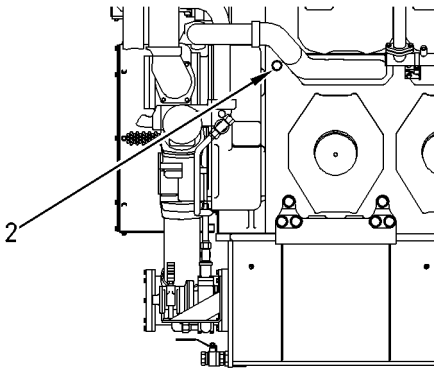


g00788934

Illustration 43

A drain plug is located on the right side near the rear of the engine.

(1) Plug



g00788946

Illustration 44

A drain plug is located on the left side near the front of the engine.

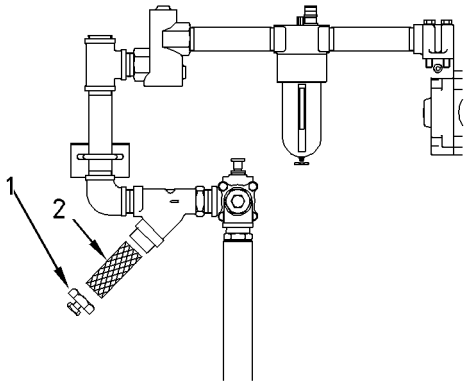
(2) Plug

1. Ensure that the engine is not running.
2. Remove plugs (1) and (2).
3. Drain the moisture into suitable containers.
4. Install the plugs.

i01762654

Air Starting Motor Lines Screen - Clean

SMCS Code: 1451-070-LI



g00789123

Illustration 45

(1) Plug
(2) Screen

If the engine is equipped with an air starting motor, use the following procedure:

1. Ensure that the air supply to the air lines is OFF.
2. Remove plug (1).
3. Carefully remove screen (2). Clean the screen with nonflammable solvent. Inspect the screen for damage. If the screen is damaged, replace the damaged screen with a new screen.
4. Install clean, dry screen (2). Clean plug (1). Install the plug.

i02654935

Air Starting Motor Lubricator Bowl - Clean

SMCS Code: 1451-070

If the engine is equipped with an air starting motor, use the following procedure:

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Ensure that the air supply to the lubricator is OFF.

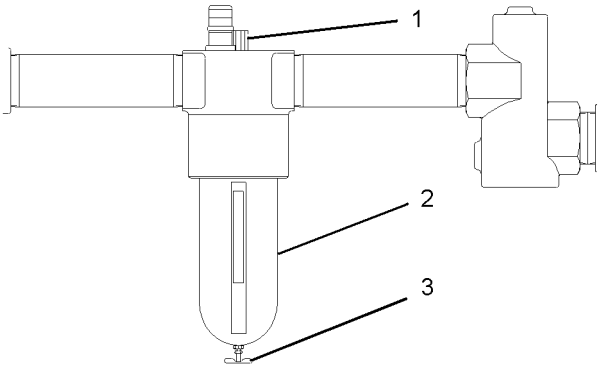


Illustration 46 g01333332

(1) Filler plug
(2) Bowl
(3) Drain valve

2. Slowly loosen filler plug (1) in order to release the pressure from the lubricator.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

3. Place a suitable container under bowl (2) and open drain valve (3) in order to drain the oil from the bowl.

4. Remove bowl (2). Clean the bowl with warm water.

5. Dry the bowl. Inspect the bowl for cracks. If the bowl is cracked, replace the damaged bowl with a new bowl. Inspect the gasket. If the gasket is damaged, replace the gasket.

6. Install the bowl.

7. Make sure that drain valve (3) is closed.

8. For instructions on filling the lubricator, see this Operation and Maintenance Manual, “Air Starting Motor Lubricator Oil Level - Check” topic.

i02654969

Air Starting Motor Lubricator Oil Level - Check

SMCS Code: 1451-535

NOTICE
Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.

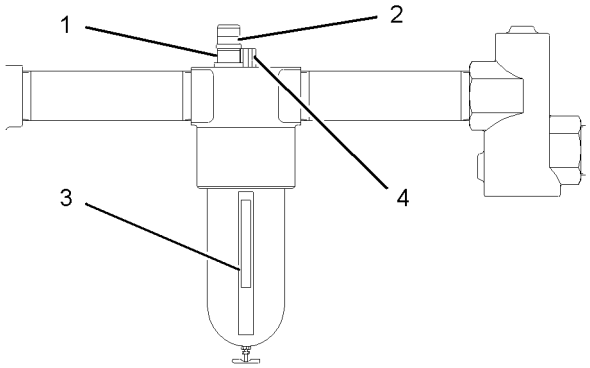


Illustration 47 g01333366

1. Observe the oil level in sight gauge (3). If the oil level is less than 1/2, add oil to the lubricator bowl.

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

2. Ensure that the air supply to the lubricator is OFF. Slowly loosen filler plug (4) in order to release pressure from the lubricator bowl.

3. Remove filler plug (4). Pour oil into the lubricator bowl. Use nondetergent SAE 10W oil for temperatures that are greater than 0 °C (32 °F). Use air tool oil for temperatures that are below 0 °C (32 °F).

4. Install filler plug (4).

Adjust the Lubricator

Note: Adjust the lubricator with a constant rate of air flow. After the adjustment, the lubricator will release oil in proportion to variations of the air flow.

1. Ensure that the fuel supply to the engine is OFF.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

2. Operate the air starting motor. Observe the drops of oil that are released in dome (1).

Note: Some lubricators have an adjustment screw rather than a knob.

3. If necessary, adjust the lubricator in order to release from one to three drops of oil per second. To increase the rate, turn knob (2) counterclockwise. To decrease the rate, turn the knob clockwise.

i00351324

Air Tank Moisture and Sediment - Drain

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

WARNING

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.

2. Close the drain valve.

i02601719

Alternator - Inspect

SMCS Code: 1405-040

Inspect the alternator for the following conditions:

- Proper connections
- Clean ports for cooling airflow
- Proper charging of the battery

Observe battery voltage on the Advisor panel or Cat ET during engine operation to evaluate the performance of the alternator.

Make repairs, if necessary. See the Service Manual for service procedures. Consult your Caterpillar dealer for assistance.

i02601741

Barring Device - Lubricate

SMCS Code: 1235-086

NOTICE
Do not use an impact wrench to operate the barring device. The use of an impact wrench will cause gear tooth failure.

WARNING

Guards must be in place prior to operating barring device motor.

Remove all hand tools prior to operating barring device motor.

Note: Prelube of the engine is required before the crankshaft is rotated for normal maintenance.

The barring device provides a means for slowly turning the flywheel in order to service the engine. When the barring device is in the engaged position, the engine starting system is disabled.

When the barring device is not used, the barring device must be fully disengaged from the flywheel and secured in the disengaged position. Refer to the Service Manual for information on operation of the barring device.

NOTICE
Do not operate the engine starting motor until the barring group pinion gear is fully disengaged from the flywheel ring gear. Serious damage to the engine could result.

Electric Barring Device

Note: This type of barring device may be electrically driven or manually driven.

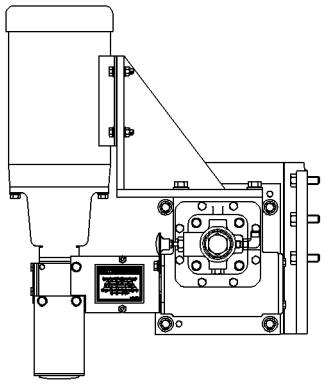


Illustration 48 g00334420

Rear view of an electrically driven barring device

Lubricating the Pinion

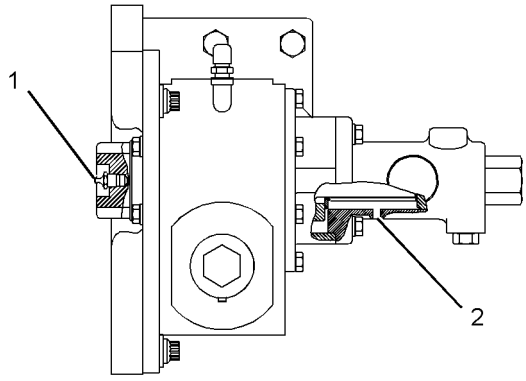


Illustration 49 g01098831

Section view of a barring device without the electric motor

(1) Grease fitting
(2) Vent

1. Ensure that the barring device is locked in the disengaged position.
2. Lubricate grease fitting (1) with Cat Advanced 3Moly Grease until the grease is visible at vent (2).

Lubricating the Reducer

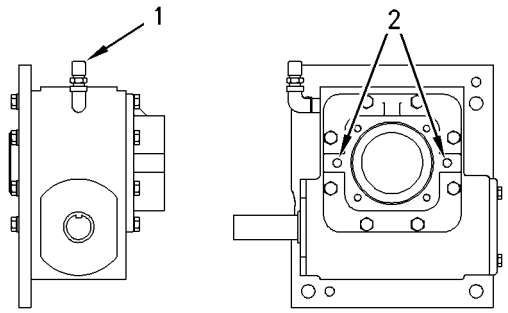


Illustration 50 g00991445

1. Ensure that the barring device is locked in the disengaged position.
2. Remove level plugs (2) and check the lubricant level.
3. If necessary, remove cap (1) and add Caterpillar 4C-6767 Synthetic Oil until the oil is visible at the level plugs.
4. Reinstall the level plugs and reinstall the cap.

Manual Barring Device

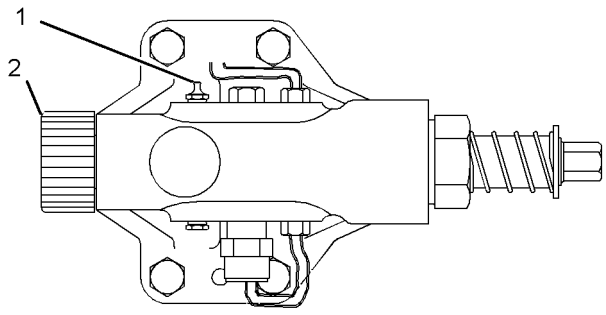


Illustration 51 g01098833

(1) Grease fitting
(2) Gear end

1. Ensure that the barring device is locked in the disengaged position.
2. Lubricate grease fitting (1) with Cat Advanced 3Moly Grease until the grease is visible at gear end (2).

i02601752

Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

   If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

   Clean the battery case with one of the following cleaning solutions:

   - A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
   - A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

   Thoroughly rinse the battery case with clean water.

   Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i02601764

Belts - Inspect/Adjust/Replace

SMCS Code: 1357-025; 1357-040; 1357-510

Inspection

Inspect the alternator belt and the fan drive belts for wear and for cracking. Replace the belts if the belts are not in good condition.

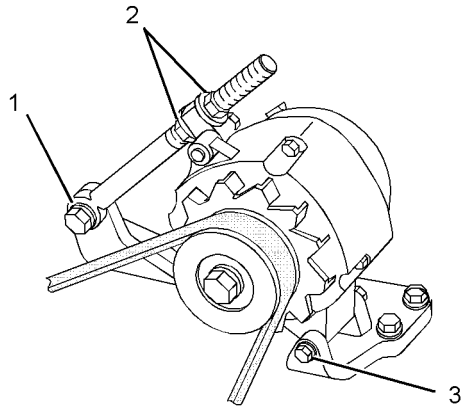
Check the belt tension according to the information in the Service Manual, “Specifications”.

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the following components:

- Belts
- Pulleys
- Bearings

If the belts are too tight, unnecessary stress is placed on the components. This reduces the service life of the components.

Adjusting the Alternator Belt



g01092641

Illustration 52

Typical alternator

(1) Mounting bolt
(2) Adjusting nuts
(3) Mounting bolt

1. Remove the drive belt guard.

2. Loosen mounting bolt (1), adjusting nuts (2) and mounting bolt (3).

3. Turn adjusting nuts (2) in order to increase or decrease the drive belt tension.

4. Tighten adjusting nuts (2). Tighten mounting bolt (3). Tighten mounting bolt (1). For the proper torque, see the Service Manual, “Specifications” module.

5. Reinstall the drive belt guard.

If new drive belts are installed, check the drive belt tension again after 30 minutes of engine operation at the rated rpm.

Adjusting the Fan Drive Belt

Note: Do not overtighten the drive belts. Overtightening can result in failure of the drive shaft.

Replacement

For applications that require multiple drive belts, replace the drive belts in matched sets. Replacing one drive belt of a matched set will cause the new drive belt to carry more load because the older drive belts are stretched. The additional load on the new drive belt could cause the new drive belt to fail.

i02601781

Combustion Sensor - Clean/Inspect/Replace

SMCS Code: 1900; 1905

To provide a signal without interference to the engine control module, the sensor must be in good condition. The connections must be clean.

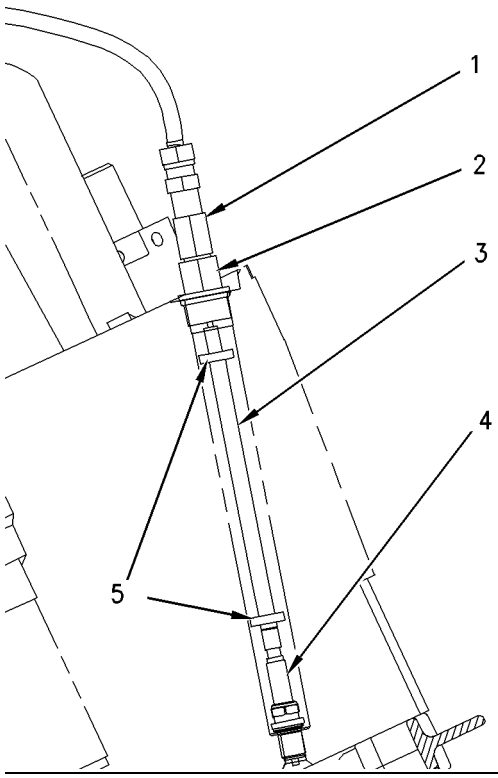


Illustration 53 g00789241

Section view of a cylinder head with a combustion sensor

(1) Harness connector
(2) Connector
(3) Extension
(4) Sensor
(5) Gasket
(6) Discs

Note: Use of a platform may be necessary to reach the combustion sensor.

Note: Clean the connections and polish the connections with a clean, dry cloth. Always install a new O-ring seal in connector (1) when the combustion sensor is serviced.

1. Disconnect harness connector (1) from connector (2). Remove the O-ring seal from the harness connector. Clean the end of the harness connector. Install a new O-ring seal.

2. Remove connector (2). Clean the inside of the connector's adapters.

3. Remove extension (3). Clean both ends of the extension.

⚠ WARNING

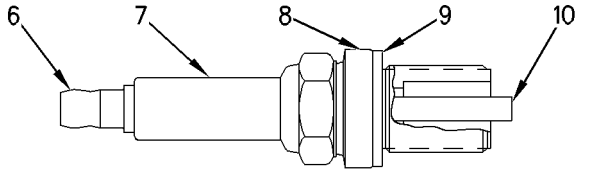
Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.

Note: The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi).

4. The area around sensor (4) may have debris. Thoroughly remove any debris. Use compressed air. Ensure that the area around the sensor is clean and free of debris.

5. Loosen sensor (4) with a 15.9 mm (5/8 inch) spark plug socket and an extension. After the sensor has been loosened, remove the sensor by hand in order to detect problems with the threads.

If the sensor resists removal by hand, apply penetrating oil to the threads. Use the wrench and apply steady pressure to the sensor until the sensor is loose.



g00789274

Illustration 54

Combustion sensor

(6) Terminal post
(7) Insulator
(8) Shell
(9) Gasket
(10) Electrode

6. After the sensor is removed, discard gasket (9).

7. Inspect the sensor closely for damage.

Terminal post (6) must not move. If the terminal post can be moved by hand, discard the sensor.

Inspect insulator (7) for cracks. If a crack is found, discard the sensor.

Inspect shell (8) for damage. Cracks can be caused by overtightening the sensor. Overtightening can also loosen the shell. Discard any sensor that has a shell that is cracked or loose.

Inspect electrode (10) for excessive wear.

Light brown deposits or beige deposits around the electrode is produced by normal operation. White deposits or gray deposits may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system

A buildup of ash on the electrode reduces the efficiency of the sensor.

8. Measure the resistance between terminal post (6) and electrode (10).

The sensor must pass a low voltage check for continuity between the terminal post and the electrode. The resistance must not exceed five ohms.

9. Thoroughly clean the sensor.

Clean the shell and the electrode that is inside of the shell. Do not use a wire brush. Glass beads are the preferred method for cleaning. Follow these guidelines for the use of glass beads:

- Always use clean glass beads.
- Use care in order to clean only the electrode and the insulator near the electrode.
- Do not use glass beads on the outside of the shell or on the upper part of the insulator.

Ensure that the sensor is clean and free of dirt and oil.

Note: Do not use anti-seize compound on the sensor. Most of the heat is transferred through the threads and the seat area of the sensor. The surfaces must be in contact in order to provide the heat transfer that is required.

10. Place a new 108-3515 Plug Gasket on the sensor. Install the sensor by hand until the sensor bottoms out. Tighten the sensor to 38 ± 2 N·m (28 ± 2 lb ft).

11. Install extension (3). Make sure that discs (5) are positioned in order to align the extension's connectors with sensor (4) and connector (2).

12. Make sure that the O-ring seal on connector (2) is in good condition. Install the connector.

13. Attach harness connector (1) to connector (2).

i01762721

Control Panel - Inspect

SMCS Code: 4490-040; 7451-040

Inspect the condition of the panel. If a component is damaged, ensure that the component is repaired or that the component is replaced. If equipped, ensure that the electronic displays are operating properly.

Inspect the wiring for good condition. Ensure that the wiring connections are secure.

Record the Data and Review the Data

If equipped, check the gauges and check the indicators frequently during normal operation. Record the data in a log. Compare the new data to the data that was previously recorded. Comparing the new data to the recorded data will establish the normal gauge readings for the engine. A gauge reading that is abnormal may indicate a problem with operation or with the gauge.

i02601979

Cooling System Coolant (NGEC) - Change

SMCS Code: 1350-044

Clean the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.

NOTICE
Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

Drain the Cooling System

1. Stop the engine and allow the engine to cool. Ensure that the engine will not start when the cooling system is drained.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

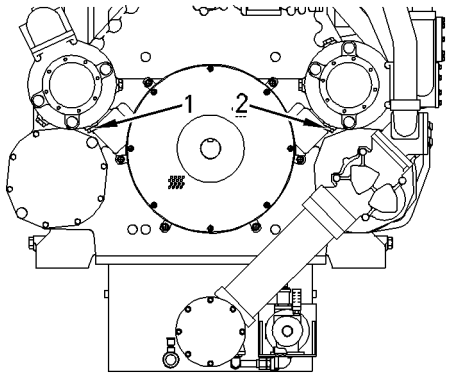


Illustration 55 g00792409

Location of cooling system drain valves or drain plugs on the water pumps

(1) Jacket water pump
(2) Aftercooler and oil cooler pump

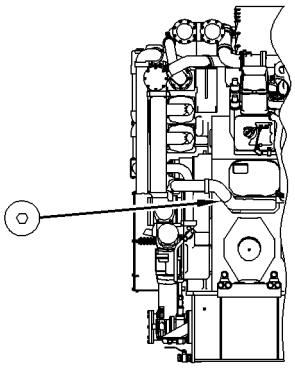


Illustration 56 g00901833

Location of drain plug for the jacket water system

3. Open the cooling system drain valves (if equipped). Remove the cooling system drain plugs. Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Dealer Service Tools Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Clean the Cooling System

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute in order to avoid air locks. Proper venting of the cooling system is essential to fill at this rate.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine. Operate the engine for a minimum of 30 minutes with a coolant temperature of at least 82 °C (180 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valves (if equipped). Remove the cooling system drain plugs. Allow the water to drain.

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

Cleaning a Cooling System that has Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be an active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start the engine. Operate the engine for a minimum of 90 minutes with a coolant temperature of at least 82 °C (180 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the cooling system drain valves (if equipped). Remove the cooling system drain plugs. Allow the water to drain.

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain valves (if equipped). Clean the cooling system drain plugs and install the cooling system drain plugs.

Fill the Cooling System

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute in order to avoid air locks. Proper venting of the cooling system is essential to fill at this rate.

Note: For information about the proper coolant to use, and the capacity of the cooling system, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” (Maintenance Section).

1. Fill the cooling system with coolant/antifreeze. Do not install the cooling system filler cap.

2. Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the coolant to warm and allow the coolant level to stabilize. Stop the engine.

3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant to the level that is specified by the OEM of the cooling system.

4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets of the cooling system filler cap are damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gaskets of the cooling system filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02062976

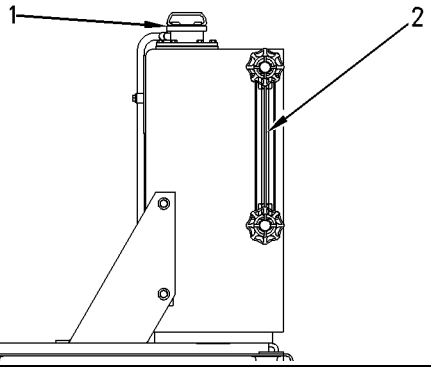
Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

WARNING

Climbing equipment may be required to access this service point. Refer to the Operation and Maintenance Manual, "Mounting and Dismounting" topic for safety information.

Engines That Are Equipped With a Sight Gauge



g00750429

Illustration 57

(1) Filler cap
(2) Sight gauge

If the engine is equipped with a sight gauge, observe the position of the coolant in the sight gauge. At normal operating temperature, the proper coolant level is in the upper half of the sight gauge. If the coolant level is low, add the proper coolant mixture.

Engines That Are Not Equipped With a Sight Gauge

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

Check the coolant level when the engine is stopped and cool. Check the coolant level only after the engine has been stopped and the cooling system filler cap is cool enough to touch with your bare hand.

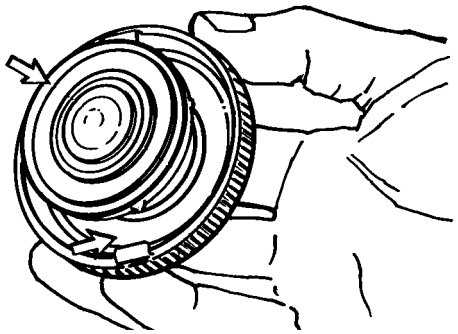
Remove the cooling system filler cap slowly in order to relieve any pressure. Maintain the coolant within 13 mm (0.5 inch) below the bottom of the filler pipe.

Add Coolant

Note: For the proper coolant mixture to use, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).

1. Stop the engine. Allow the engine to cool.

2. Remove the cooling system filler cap slowly in order to relieve any pressure. Pour the proper coolant mixture into the filler pipe.



g00103639

Illustration 58

Gaskets

3. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

4. Start the engine. Inspect the cooling system for leaks.

i02064894

Cooling System Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

For conventional heavy-duty coolant/antifreeze, check the concentration of supplemental coolant additive (SCA) regularly. The concentration of SCA can be checked with an S·O·S coolant analysis (Level 1).

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.
- Keep the unused sampling bottles stored in plastic bags.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- In order to avoid contamination, immediately place the sample in the tube that is provided for mailing.

Submit the sample for Level 1 analysis.

Note: Level 1 results may indicate a need for Level 2 Analysis.

For additional information about coolant analysis, see the Special Publication, SEBU6400, “Caterpillar Gas Engine Lubricant, Fuel and Coolant Recommendations” or consult your Caterpillar dealer.

i02168823

Cooling System Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Refer to this Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 1) - Obtain” (Maintenance Section) for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see the Special Publication, SEBU6400, “Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations” or consult your Caterpillar dealer.

i01519993

Cooling System Level Switch - Inspect

SMCS Code: 7422-040

The low coolant level switch actuates an alarm or a shutoff if the coolant level is low. A low coolant level could cause the engine to overheat. This could result in damage to the engine.

If the coolant level is low, coolant must be added to the expansion tank or the heat exchanger.

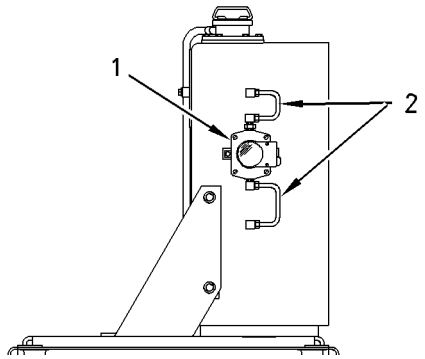


Illustration 59 g00789360

(1) Switch
(2) Lines

For proper operation of the switch, the lines and the switch must be clean.

1. Drain the coolant to a level below lower line (2). Drain the coolant into a clean container so that the coolant can be reused.
2. Remove switch (1). Inspect the openings of the inlet and the outlet for plugging. If an opening is plugged, clean the switch.
3. Inspect lines (2) for plugging. Clean the lines, if necessary. Pressure air or a flexible wire can be used to clean the lines.
4. Install switch (1).
5. Pour the coolant into the cooling system. Verify that the low coolant level switch is operating properly. A switch that is operating properly will activate an alarm until a sufficient amount of coolant is added.

i02017557

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

⚠ WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system coolant additive.

Note: Caterpillar recommends an S·O·S coolant analysis (Level 1).

Test the Concentration of the SCA

Coolant/Antifreeze and SCA

NOTICE
Do not exceed the recommended six percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Follow the instructions that are provided in the kit.

Water and SCA

NOTICE
Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Use the instructions that follow:

1. Fill the syringe to the “1.0 ml” mark with the coolant.
2. Dispense the 1.0 mL coolant sample from the syringe into the empty mixing bottle.
3. Add tap water to the mixing bottle in order to bring the level up to the “10 ml” mark. Place the cap on the bottle and shake the bottle.
4. Add 2 to 3 drops of the “NITRITE INDICATOR SOLUTION B” to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
5. Add 1 drop of “NITRITE TEST SOLUTION A” to the mixing bottle. Move the bottle in a circular motion in order to mix the solution.
6. Repeat 5 until the solution changes color from red to light gray, green, or blue. Record the number of drops of “NITRITE TEST SOLUTION A” that were required to cause the color change.
7. Use Table 36 to interpret the results.

Table 36

Number of Drops	Concentration of SCA	Maintenance Required
Less than 25	Less than the recommended concentration of SCA	Add SCA. Retest the coolant.
25 to 30	The recommended concentration of SCA	None
More than 30	More than the recommended concentration of SCA	Remove the coolant. Replace with water only Retest the coolant.

Add the SCA, If Necessary

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly.

Note: Always dispose of fluids according to local regulations.

2. If necessary, drain some coolant in order to allow space for the addition of the SCA.

NOTICE
Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

3. Add the proper amount of SCA. The concentration of the SCA depends on the type of coolant that is used. To determine the proper amount, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic.

4. Clean the cooling system filler cap. Install the cooling system filler cap.

i02168842

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulators for these systems:

- Jacket water
- Oil cooler
- Aftercooler

Replace the water temperature regulators before the water temperature regulators fail. This is a recommended preventive maintenance practice. Replacing the water temperature regulators reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or a seizure of the pistons.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner. Also, a low temperature can allow moisture to condense in the oil. This can form damaging acids.

NOTICE
Failure to replace the water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Never operate an engine without the water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i02602965

Crankcase Blowby - Measure/Record

SMCS Code: 1317

Note: The typical crankcase blowby on a new engine is approximately 0.02 m^3/bkW h (.50 ft^3/bhp h).

Measure the crankcase blowby of new engines. Record the data. Continue to periodically measure the crankcase blowby. Comparing the recorded data to the new data provides information about the condition of the engine.

Note: Crankcase blowby is one of the three factors that help to determine the in-frame overhaul interval. For more information, see the Operation and Maintenance manual, “Overhaul (In-Frame)” topic in the Maintenance Section.

After a new engine is used for a short time, the crankcase blowby can decrease as the piston rings are seated. The crankcase blowby will gradually increase as the following components show wear:

- piston rings
- cylinder liners

Note: A problem with the piston rings causes the oil to deteriorate rapidly. Information regarding the condition of the piston rings can be obtained from the measurement of the crankcase blowby and the results of oil analysis.

The crankcase blowby of a worn engine may exceed the crankcase blowby of a new engine by two times or more.

A sudden increase in crankcase blowby could indicate a broken piston ring. The following conditions are other potential sources of crankcase blowby:

- Worn valve guides
- A turbocharger seal that leaks

A rebuilt engine can have a high crankcase blowby due to the following factors:

- The piston rings are not seated properly.
- Worn parts such as valve guides were not replaced.

Excessive crankcase blowby may indicate the need for an overhaul. By keeping a record of the results, a gradual increase in the amount of the crankcase blowby will be noted until the amount of crankcase blowby has become excessive.

Use the 1U-8860 Large Engine Blowby Pickup Group to measure the blowby. Refer to Special Instruction, SEHS8984, “1U-8860 Large Engine Blowby Pickup Group” that is provided with the tool.

Record the crankcase blowby for the engine. Keep a record of the results.

For more information, see the Service Manual, “Systems Operation/Testing and Adjusting”. For assistance, consult your Caterpillar dealer.

i02062446

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

The crankshaft vibration damper limits the torsional vibration of the crankshaft. The visconic damper has a weight that is located inside a fluid filled case.

Damage to the crankshaft vibration damper or failure of the damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

A damper that is hot is due to excessive torsional vibration. Monitor the temperature of the damper during operation.

The 8T-2821 Temperature Indicator or the 8T-2822 Temperature Indicator are recommended for monitoring the temperature of the damper. Evenly space four of the adhesive indicators around the outer diameter of the damper.

Note: If you use an infrared thermometer to monitor the temperature of the damper, use the thermometer during operation with similar loads and speeds. Keep a record of the data. If the temperature begins to rise, reduce the interval for inspecting the damper. It is important to regularly monitor the temperature of the damper. It is important to document the temperature of the damper when it increases and decreases. This will verify that damper service is necessary.

If the temperature of the damper reaches 110 °C (230 °F), consult your Caterpillar dealer.

Inspect the damper for evidence of dents, cracks, and leaks of the fluid.

If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and sticky. If leaking silicone is found, repair the damper or replace the damper.

If the fluid leak is oil, inspect the crankshaft seal for leaks. If a leak is observed, replace the seal.

Inspect the damper and repair or replace the damper for any of the following reasons.

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- An analysis of the oil has revealed that the front bearing of the crankshaft is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Removal and Installation

Refer to the Service Manual, “Disassembly and Assembly” or consult your Caterpillar dealer for information about damper replacement.

i02602007

Cylinder Pressure - Measure/Record

SMCS Code: 1223-082-CC; 1223; 7450-082

Measure the cylinder pressure of new engines. Record the data. Continue to periodically measure the cylinder pressure. Comparing the recorded data to the new data provides information about the condition of the engine.

Note: Cylinder pressure is one of the three factors that help to determine the in-frame overhaul interval. For more information, refer to this Operation and Maintenance manual, “Overhaul (In-Frame)” (Maintenance Section).

Cylinder pressure can be measured during inspection of the spark plugs. Use the following guidelines for checking the cylinder pressure:

- Remove all of the spark plugs.
- Verify that the choke is fully open.
- Minimize the cranking time. This will enable a maximum consistent cranking speed for the check. Also, the starting air or battery power will be conserved.

A loss of cylinder pressure or a change of pressure in one or more cylinders may indicate the following conditions. These conditions may indicate a problem with lubrication:

- Excessive deposits
- Guttering of valves
- A broken valve
- A piston ring that sticks
- A broken piston ring
- Worn piston rings
- Worn cylinder liners

If the cylinder pressure has risen by one or more compression ratios, the engine needs a top end overhaul in order to remove deposits. Failure to remove the deposits will increase the chance for detonation. Severe guttering of the valves will occur.

To measure the cylinder pressure, refer to Special Instruction, GMG00694, “Analyzing Cylinder Condition By Measuring Air Flow”. Also, use the 146-2739 Cylinder Pressure Adapter.

Illustration 60 is a graph of typical cylinder pressures for engines with different compression ratios.

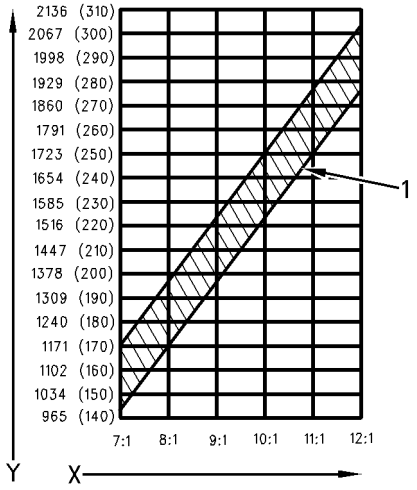


Illustration 60 g00789376

(Y) Cylinder pressure in kPa (psi)
(X) Compression ratio
(1) Normal range for cylinder pressure

Record the pressure for each cylinder. Use Operation and Maintenance Manual, “Valve Data Sheet” (Reference Materials Section).

i01765658

Cylinders - Inspect (Inspect the Combustion Chamber)

SMCS Code: 1223-040; 1223

Excessive deposits can accumulate in the combustion chambers of engines that use gas with a low BTU such as bio-gas fuel, landfill gas, etc. The deposits can affect the characteristics of combustion. Erratic operation can result. The rate of recession of the exhaust valves can increase. The risk of guttering of the exhaust valves can increase.

Note: Use of a platform may be necessary to inspect the combustion chamber.

Use a borescope to inspect the combustion chamber. The inspection will provide information about the internal condition of the engine.

A borescope with a lens that can be rotated is recommended. This type of borescope provides a clear view of the combustion chamber and of the bottom deck of the cylinder head. Photographic documentation or video documentation is also recommended. Consult your Caterpillar dealer for information on available borescopes.

When possible, insert the borescope through the opening in the cylinder head for the prechamber assembly and the ignition body. This location will provide the best possible view of the entire combustion chamber. This requires draining the coolant to a level below the cylinder head. If this is not possible, insert the borescope through the opening for the combustion sensor. Look for the following conditions:

- Valve wear
- Deposits on the valve seat
- Deposits on the valve face
- Polishing of the cylinder walls
- Scratching of the cylinder walls
- Deposits on the cylinder walls that are above the upper limit of the piston stroke

Deposits that are on the valve face and the valve seat can cause guttering of the valve. Inspect the valve seat and the valve face for excessive deposits. If excessive deposits are found, replace the valve and the valve seat.

Determine whether the exhaust valve face has erosion from pitting. This requires the exhaust valve to be in the open position. To obtain as much detail as possible, obtain a close up view of the valve face. Erosion of the exhaust valve face can lead to guttering of the valve. If erosion is found on the exhaust valve face, recondition the cylinder head as soon as possible.

Note: Operation at loads that are less than 50 percent of the rated load can result in an excessive buildup of carbon deposits in the combustion chamber. The deposits can lead to detonation and premature ignition. This condition is more obvious at certain engine speeds and loads.

i02602013

Driven Equipment - Check

SMCS Code: 3279-535

Every 5000 Service Hours

Engines That Are Not Attached To the Base with a Dowel

If some engines are too rigidly mounted, excessive stress may affect the internal support of the cylinder block. This could cause the following problems:

- Distortion of the bores of the main bearing
- Distortion of the alignment of the bore

Severe damage to the engine could result. The service life of the engine could be severely reduced.

For engines that are not attached to the base with a dowel, check the following:

- Check the alignment after every 5000 service hours.
- Inspect the drive coupling according to the specifications of the OEM.

Every 10,000 Service Hours

Engines That Are Attached To the Base with a Dowel

Some engines must be more rigidly mounted. Due to thermal expansion, a cold engine will expand after the engine achieves operating temperature.

Some engines are attached to the base with a dowel in the rear mounting support. This installation forces the thermal growth forward. The driven equipment is also attached with a dowel in order to maintain alignment with the engine.

For this type of installation, check the alignment after every 10,000 service hours.

Check the Alignment

The alignment between the engine and the driven equipment must be maintained properly. Improper alignment will cause damage to the engine, the coupling, and the driven equipment.

Check the alignment according to the instructions that are provided by the following manufacturers:

- Caterpillar
- OEM of the coupling
- OEM of the driven equipment

i00935098

Driven Equipment - Inspect/Replace/Lubricate

SMCS Code: 3279-040

Observe the driven equipment during operation. Look for the following items:

- Unusual noise and vibration
- Loose connections
- Damaged parts

Perform any maintenance that is recommended by the OEM of the driven equipment. Refer to the literature of the OEM of the driven equipment for the following service instructions.

- Inspection
- Lubricating grease and lubricating oil requirements
- Specifications for adjustment
- Replacement of components
- Requirements for ventilation

i01610487

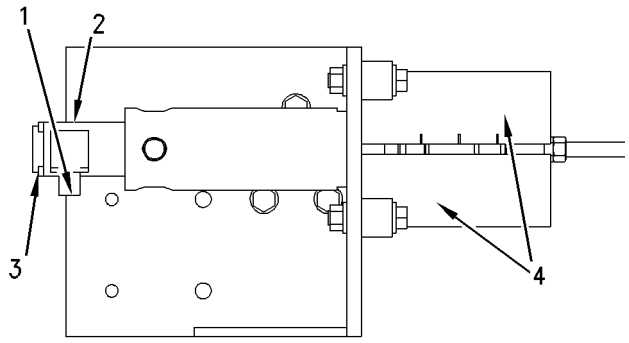
Electrohydraulic Actuator - Inspect

SMCS Code: 1716-040

Inspect the actuators for the fuel control, the wastegate, and the air choke.

⚠ WARNING

During operation, the linkage of the electrohydraulic actuators can form pinch points which can cause personal injury. Shut down the engine before you service the electrohydraulic actuators.



g00833473

Illustration 61

(1) Receptacle for the wiring harness
(2) Solenoid
(3) Bolt
(4) Guards

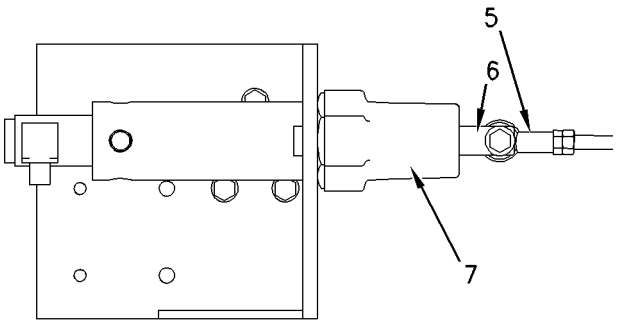
1. Disconnect the wiring harness from receptacle (1). Inspect the connectors for damage and corrosion. Make repairs, if necessary.

2. Inspect the joint between solenoid (2) and the housing for leaks.

   If a leak is found between the solenoid and the housing, replace the O-ring seal for the solenoid. For instructions, refer to this Operation and Maintenance Manual, “Electrohydraulic Actuator - Recondition”.

3. Check the solenoid's mounting bolts (3) for tightness.

4. Remove guards (4).



g00833477

Illustration 62

(5) Rod end
(6) Clevis
(7) Boot

5. Disconnect rod end (5) from clevis (6).

6. Remove clevis (6).

7. Remove rubber boot (7). Inspect the boot for damage. If the boot is damaged, obtain a new boot for assembly.

   There may be a small amount of hydraulic fluid inside of the boot. Wipe off the boot and reinstall the boot.

   If an excessive amount of hydraulic fluid is found inside the boot, the seal for the actuator's shaft is probably worn. If this is the case, replace the piston assembly. For instructions, refer to this Operation and Maintenance Manual, “Electrohydraulic Actuator - Recondition”.

8. Install boot (7). Make sure that the outer end of the boot folds inward when the actuator's shaft moves from the fully open position to the fully closed position.

9. Install clevis (6). Connect rod end (5) to the clevis.

10. Install guards (4).

11. Connect the wiring harness to receptacle (1).

i01610640

Electrohydraulic Actuator - Recondition

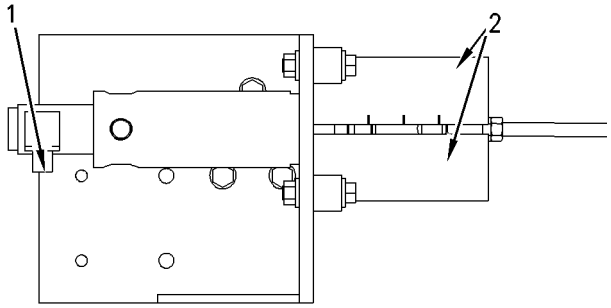
SMCS Code: 1716-020

Recondition the actuators for the fuel control, the wastegate, and the air choke. The main components of each actuator include the housing, a piston assembly, and a solenoid which actuates the piston. The piston assembly and the solenoid can be serviced separately.

Note: New parts or remanufactured parts may be used for reconditioning the actuators.

⚠ WARNING

During operation, the linkage of the electrohydraulic actuators can form pinch points which can cause personal injury. Shut down the engine before you service the electrohydraulic actuators.



g00833592

Illustration 63

(1) Receptacle for the wiring harness
(2) Guards

1. Disconnect the wiring harness from receptacle (1). Inspect the connectors for damage and corrosion. Make repairs, if necessary.

2. Remove guards (2).

3. Disconnect the supply line (not shown) and the return line (not shown) for the hydraulic oil.

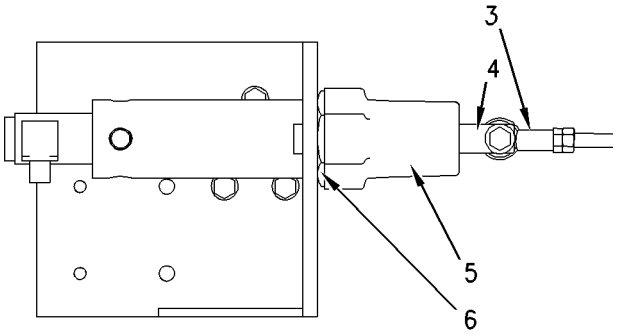


Illustration 64 g00833594

(3) Rod end
(4) Clevis
(5) Boot
(6) Nut

4. Disconnect rod end (3) from clevis (4).

5. Remove clevis (4) and rubber boot (5). Inspect the boot for damage. If the boot is damaged, obtain a new boot for assembly.

Note: Handle the actuator carefully. Use care not to damage the actuator's shaft. Damage to the shaft can result in premature failure of the O-ring seal. This will cause hydraulic fluid to leak.

6. Remove nut (6) in order to remove the actuator from the bracket.

Note: Do not allow debris to enter the actuator. Seal the openings with clean covers immediately after the solenoid and/or the piston assembly is removed.

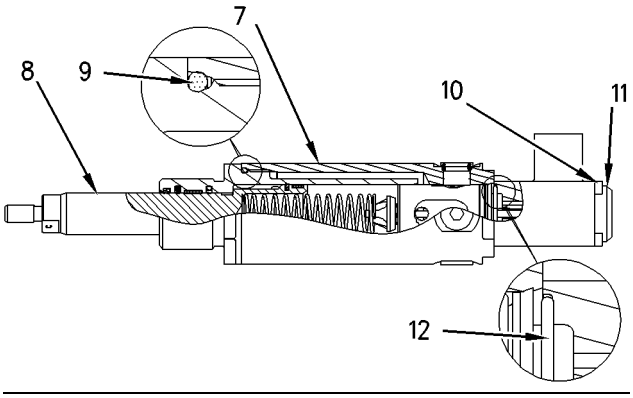


Illustration 65 g00833595

(7) Housing
(8) Piston assembly
(9) O-ring seal
(10) Bolt
(11) Solenoid
(12) O-ring seal

Note: The spring in the housing will be loose after the piston assembly is removed.

7. Place housing (7) in a vise. Remove piston assembly (8). Remove O-ring seal (9) from the joint between the piston assembly and the housing.

Note: O-ring seal (9) is included with the piston assembly.

8. Install a new O-ring seal (9) and piston assembly (8). Make sure that the spring in the housing is properly aligned in the bore of the piston. Tighten the piston assembly according to the engine's Specifications.

9. Remove bolts (10) in order to remove solenoid (11). Remove O-ring seal (12) from the joint between the solenoid and the housing.

10. Install a new O-ring seal (12) and solenoid (11). Install bolts (10). Tighten the bolts according to the engine's Specifications.

11. Install the actuator in the bracket with nut (6).

12. Install boot (5). Make sure that the outer end of the boot folds inward when the actuator's shaft moves from the fully open position to the fully closed position.

13. Install clevis (4). Connect rod end (3) to the clevis.

14. Install guards (2).

15. Connect the supply line and the return line for the hydraulic oil.

16. Connect the wiring harness to receptacle (1).

i01525261

Electrohydraulic System - Check/Adjust

SMCS Code: 1716-025; 1716-535

Check the Pressure Relief Valve

Check the pressure relief valve for the hydraulic system according to the procedure that is in Systems Operation/Testing and Adjusting. Adjust the pressure according to the instructions.

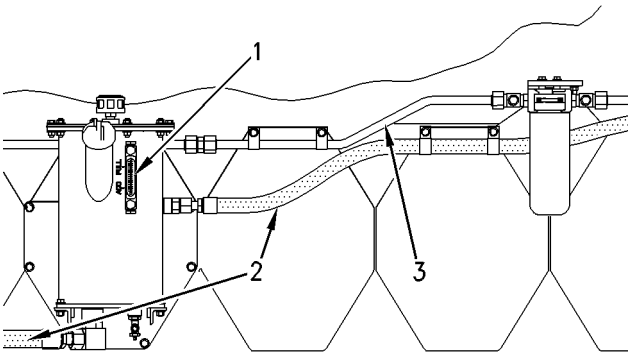
i02214104

Electrohydraulic System - Inspect

SMCS Code: 1716-040

Inspect the conditions of these items for the electrohydraulic system:

- Oil level
- Hoses, lines, connections, and components



g00792283

Illustration 66

(1) Sight gauge
(2) Hose
(3) Line

Check the Oil Level

1. Check the oil level in sight gauge (1).

   The oil should be between the “ADD” and “FULL” marks on the tank.

Note: For the proper oil to use, refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendatons” topic (Maintenance Section).

2. If necessary, remove the oil filler cap. Pour the correct oil into the oil filler.

3. Clean the oil filler cap. Install the oil filler cap.

Inspect the Lines, Connections, and Components

⚠ WARNING

The linkage can move and form a pinch point which can cause personal injury. Keep hands away from the linkage.

Inspect the hoses and lines for wear and leaks. Ensure that the hoses and lines are properly clamped. Inspect the connections for leaks. Ensure that the connections are secure.

Inspect the following items for leaks and good condition:

- Actuators
- Pressure relief valve
- Pump

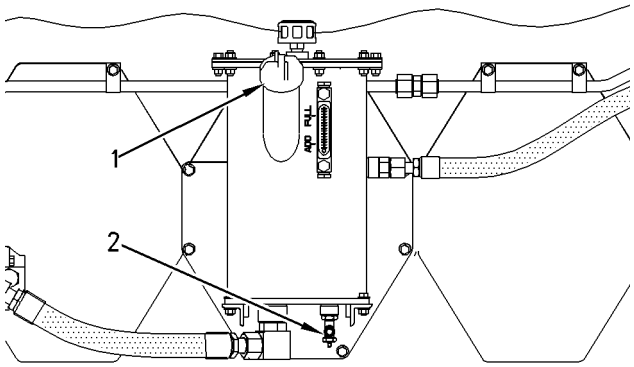
Make repairs, if necessary.

i02603161

Electrohydraulic System Oil - Change

SMCS Code: 1716-510-OC

Ensure that the engine cannot start during this procedure.



g00792335

Illustration 67

(1) Oil filler cap
(2) Valve

1. Remove oil filler cap (1).

Note: Drain the oil into a suitable container. Dispose of fluids according to local regulations.

2. Place a suitable container under valve (2). Open the valve. Allow the oil to drain. After the oil has drained, close the valve.

Note: For the proper oil to use, refer to the Special Publication, SEBU6400, “Caterpillar Gas Engine Lubricant, Fuel and Coolant Recommendations” .

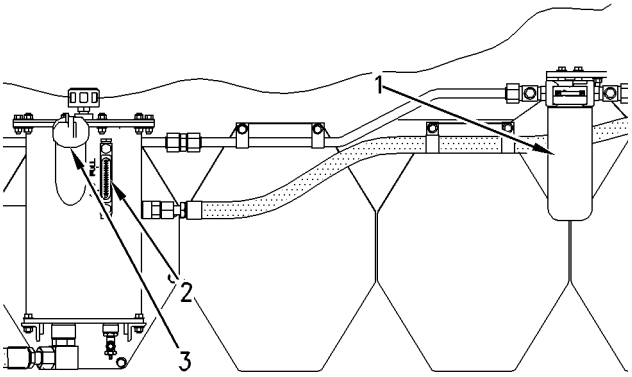
3. Pour the proper oil into the oil filler. Clean the oil filler cap. Install the oil filler cap.

4. Clean up any oil that may have spilled.

i02246458

Electrohydraulic System Oil Filter - Change

SMCS Code: 1716-510-FI



g00792302

Illustration 68

(1) Filter
(2) Sight gauge
(3) Filler cap

1. Remove filter (1) with a 1U-8760 Chain Wrench.

2. Clean the sealing surface of the filter mounting base. Ensure that all of the old filter gasket is removed.

g00103713

Illustration 69

Typical filter mounting base and gasket

Note: For the proper oil to use, refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section).

3. Apply clean hydraulic oil to the new filter gasket.

4. Install the filter by hand. Tighten the filter until the gasket contacts the mounting base. Tighten the filter according to the instructions that are shown on the filter. Do not overtighten the filter.

5. Start the engine. Check the oil level in sight gauge (2). The oil should be between the “ADD” and “FULL” marks on the tank. If necessary, remove oil filler cap (4). Pour the correct oil into the oil filler. Clean the oil filler cap. Install the oil filler cap.

i02169249

Engine Air Cleaner Element (Single Element) - Clean/Replace

SMCS Code: 1051; 1054-037

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

Note: Use of a platform may be necessary to reach the air cleaner element.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.

- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.

- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.

- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

1. Remove the air cleaner cover. Remove the air cleaner element.

Note: Refer to “Cleaning the Air Cleaner Elements”.

2. Cover the air inlet with tape in order to keep dirt out.

3. Clean the inside of the air cleaner cover and body with a clean, dry cloth.

4. Remove the tape for the air inlet. Install an air cleaner element that is new or cleaned.

5. Install the air cleaner cover.

6. Reset the air cleaner service indicator.

Cleaning the Air Cleaner Elements

NOTICE
Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

The air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the air cleaner element is cleaned, check for rips or tears in the filter material. The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean air cleaner elements while dirty elements are being cleaned.

NOTICE
Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

Pressurized air can be used to clean air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

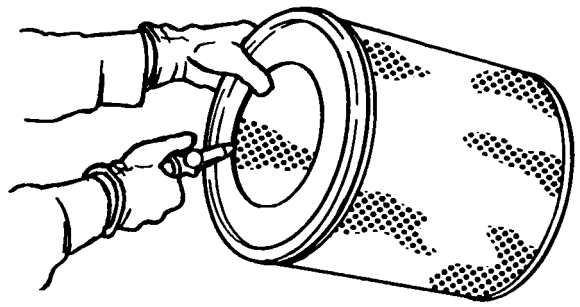


Illustration 70 g00281692

Note: When the air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Inspecting the Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Air Cleaner Elements”.

Inspecting the Air Cleaner Elements

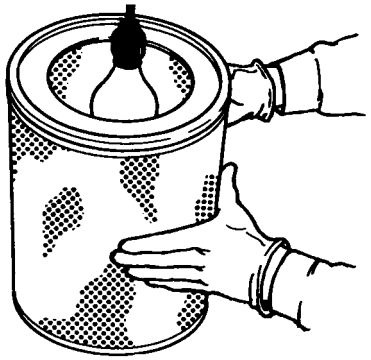


Illustration 71 g00281693

Inspect the clean, dry air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the air cleaner element. Rotate the air cleaner element. Inspect the air cleaner element for tears and/or holes. Inspect the air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the air cleaner element to a new air cleaner element that has the same part number.

Do not use an air cleaner element that has any tears and/or holes in the filter material. Do not use an air cleaner element with damaged pleats, gaskets or seals. Discard damaged air cleaner elements.

Storing Air Cleaner Elements

If an air cleaner element that passes inspection will not be used, the air cleaner element can be stored for future use.

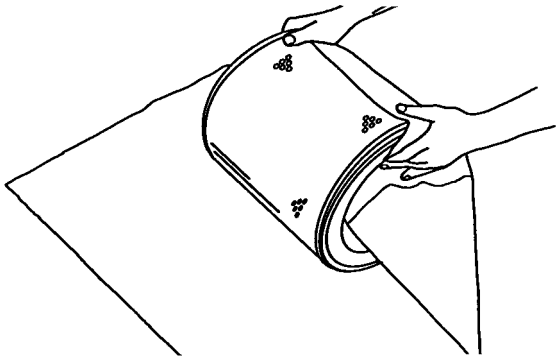


Illustration 72 g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. An airflow restriction may result. To protect against dirt and damage, wrap the air cleaner elements in Volatile Corrosion Inhibited (VCI) paper.

Place the air cleaner element into a box for storage. For identification, mark the outside of the box and mark the air cleaner element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

Crankcase Air Cleaner

Engines that are equipped with positive crankcase ventilation have an air cleaner for crankcase ventilation. Clean the air cleaner element or replace the air cleaner element when the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in a visible position.
- The air restriction reaches 0.25 kPa (1 inch of H_2O).

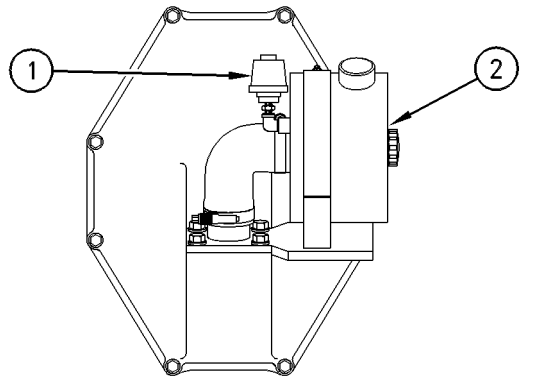


Illustration 73 g00294189

(1) Service indicator
(2) Cover

1. Remove cover (2).
2. Remove the used element and dispose of the element.
3. Clean the inside of cover (2) and clean the inside of the body.
4. Install a new element. Install cover (2).
5. Reset service indicator (1), if necessary.

i01520297

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines are equipped with an air cleaner for crankcase ventilation.

This air cleaner filters air that is drawn into the crankcase. The air dilutes the harmful fumes that may accumulate in the crankcase. The air and the fumes are drawn away from the crankcase.

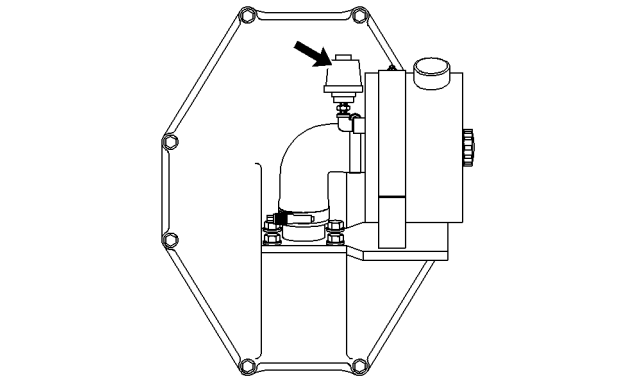


Illustration 74 g00789538

Service indicator

Observe the service indicator. Clean the air cleaner element or replace the air cleaner element when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air filter restriction reaches .25 kPa (1 inch of H_2O).

Inspect the service indicator daily for cracks, holes, or loose fittings. If any of these conditions are present, repair the service indicator or replace the service indicator.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated rpm. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, replace the service indicator. If the new service indicator will not reset, the fitting for the service indicator may be plugged.

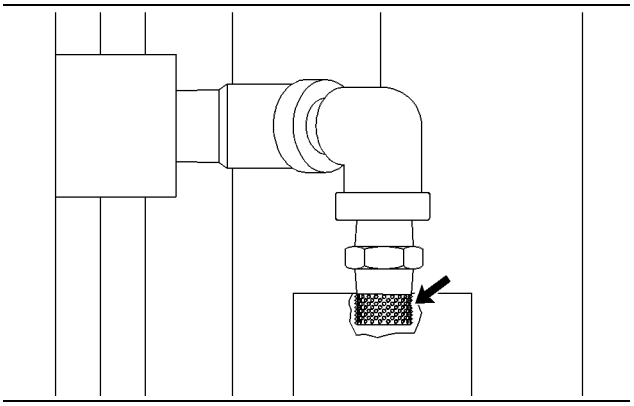


Illustration 75 g00351792

Porous filter

A porous filter is part of a fitting that is used for mounting of the service indicator. Inspect the filter for cleanliness. Clean the filter, if necessary. Use compressed air or a clean, nonflammable solvent.

The service indicator may need to be replaced frequently in environments that are severely dusty. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i00935352

Engine Air Precleaner - Clean

SMCS Code: 1055-070

Note: More frequent cleaning may be required in dusty environments.

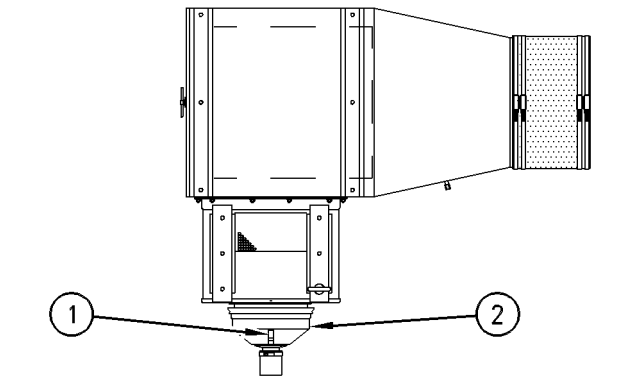


Illustration 76 g00476231

(1) Clip
(2) Cup

1. Loosen clips (1). Remove cup (2).

2. Clean the inside of the cup.

3. Install the cup. Fasten the clips.

i01765695

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that can shut down the engine. Leakage of the crankshaft seal can occur.

Note: Use of a platform may be necessary to reach the engine crankcase breather.

Perform this maintenance when the engine is stopped.

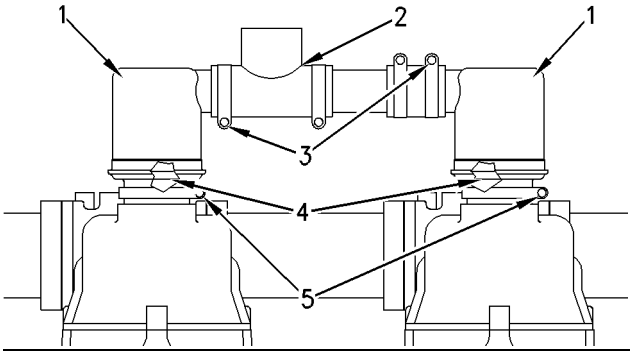


Illustration 77 g00789623

(1) Breather assembly
(2) Tee
(3) Hose clamp
(4) O-ring seal
(5) Retaining clamp

1. Loosen retaining clamps (5). Loosen hose clamps (3). Remove breather assemblies (1) and O-ring seals (4).

2. Wash the breather elements in clean nonflammable solvent. Inspect tee (2) for cracks that can be caused by vibration. Replace the old tee with a new tee if cracking is found.

3. Install new O-ring seals (4).

4. Allow the breather elements to dry before installation. Install the breather assemblies in the original position. Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier. Tighten the retaining clamps and the hose clamps according to the engine's Specifications manual.

i01612978

Engine Mounts - Check

SMCS Code: 1152-535

Check the torque of the bolts for the mounting plates. For the proper torque, refer to Gas Engines Application and Installation Guide, LEKQ7252, “G3600 Mounting, Alignment”.

Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the isolators

Settling of the isolators will result in misalignment between the engine and the driven equipment. Inspect the condition of isolators, if necessary. Keep the isolators clean and dry. Ensure that the isolators are free of oil and contamination. Inspect the isolators for deterioration.

Replace any isolator that shows deterioration. For more information, refer to the literature that is provided by the OEM of the isolators. Also refer to the following publications:

- Gas Engines Application and Installation Guide, LEKQ7252, “G3600 Mounting, Alignment”
- Special Instruction, SEHS9162, “Spring Isolator Group Installation and Adjustment Procedure”

Consult your Caterpillar dealer for assistance.

i02602019

Engine Oil - Change

SMCS Code: 1348-044; 1348

Oil Change Interval

Considerations for the oil change interval include the type of fuel and the engine application. An established S·O·S oil analysis program enables used oil to be evaluated. The evaluation can be used to determine if this oil change interval is suitable for your specific engine.

Engines That Use Bio-Gas

The oil change interval is determined by the results of oil analysis. Change the lubrication oil when oil analysis determines that the oil has reached the condemning limit. Also, change the engine oil filters.

Change the Engine Oil

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

NOTICE
Ensure that the engine is stopped before performing this procedure. Attach a DO NOT OPERATE tag to the starting controls.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed when the cold oil is drained. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will allow the waste particles to be recirculated through the engine lubrication system with the new oil.

1. After the engine has been operated at normal operating temperature, STOP the engine.

Note: Drain the oil into a suitable container. Dispose of fluids according to local regulations.

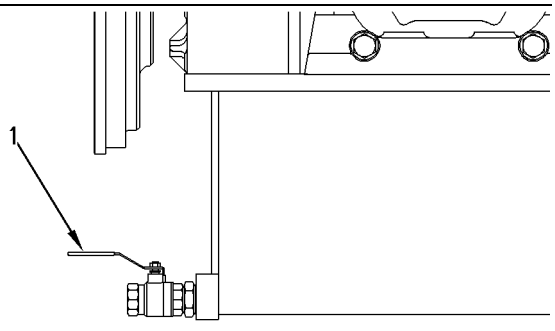


Illustration 78 g00789667

(1) Drain valve

2. Open drain valve (1) in order to drain used oil. After the oil has drained, close drain valve (1).

Note: If a suction device is used in order to remove the oil from the oil pan, ensure that the suction device is clean. This will prevent dirt from entering the oil pan. Be careful not to strike the engine oil suction tubes or the piston cooling jets.

3. Clean the oil suction screen.

Note: Approximately 1 L (1 qt) of oil will remain in the housing after the sump has been completely drained. This oil will pour out of the housing when the cover for the oil suction screen is removed. Prepare to catch the oil in a suitable container. Clean up any spilled oil with rags. DO NOT use absorbent particles to clean up the oil.

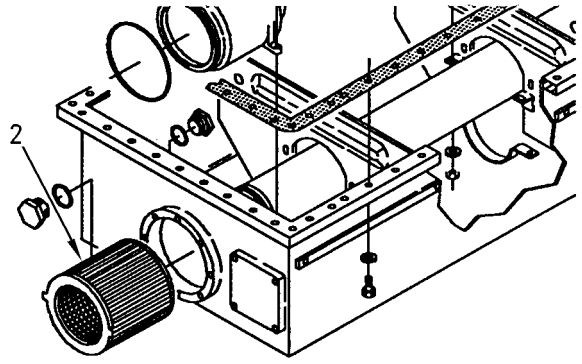


Illustration 79 g00789729

(2) Screen assembly

a. Loosen the bolts of the cover for the oil suction screen. Remove the cover and the gasket. Discard the old gasket. Slide screen assembly (2) from the tube.

b. Wash the screen assembly in clean nonflammable solvent. Allow the screen assembly to dry before installation.

c. Install the screen assembly. Install a new gasket. Install the cover.

4. Change the engine oil filters. Refer to this Operation and Maintenance Manual, “Engine Oil Filter - Change” topic (Maintenance Section).

NOTICE
Only use oils that are recommended by Caterpillar. For the proper oil to use, refer to this Operation and Maintenance Manual, “Engine Oil” topic (Maintenance Section).

NOTICE
Engine damage can occur if the crankcase is filled above the “FULL” mark on the oil level gauge (dipstick).

An overfull crankcase can cause the crankshaft to dip into the oil. This will reduce the power that is developed and also force air bubbles into the oil. These bubbles (foam) can cause the following problems: reduction of the oil's ability to lubricate, reduction of oil pressure, inadequate cooling, oil blowing out of the crankcase breathers, and excessive oil consumption.

Excessive oil consumption will cause deposits to form on the pistons and in the combustion chamber. Deposits in the combustion chamber lead to the following problems: guttering of the valves, packing of carbon under the piston rings, and wear of the cylinder liner.

If the oil level is above the “FULL” mark on the oil level gauge, drain some of the oil immediately.

Note: For the amount of oil to use, refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” (Maintenance Section).

5. Remove the oil filler cap. Fill the crankcase through the oil filler tube only. Clean the oil filler cap. Install the oil filler cap.

6. Follow this Operation and Maintenance Manual, “Starting The Engine” procedure (Operation Section). Operate the engine at low idle for two minutes. Inspect the engine for oil leaks. Ensure that the oil level is at the “FULL” mark on the “LOW IDLE” side of the oil level gauge.

7. Stop the engine and allow the oil to drain back into the sump for a minimum of ten minutes.

8. Remove the oil level gauge and check the oil level. Maintain the oil level above the “ADD” mark.

i01520518

Engine Oil Filter - Change

SMCS Code: 1308-510; 1308

Replace the engine oil filters when the following conditions are met:

- Every oil change
- The engine oil filter differential pressure reaches 100 kPa (15 psi).

Service tools are available to aid in the service of oil filters. Consult your Caterpillar dealer for the part names and the part numbers. Follow the instructions that are supplied with the service tools. If the service tools are not used, perform the following appropriate procedure.

Replacing the Engine Oil Filters With the Engine Stopped

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

Perform the following procedure after the oil has been drained.

Note: Use this procedure if the engine oil filters do not have a control valve.

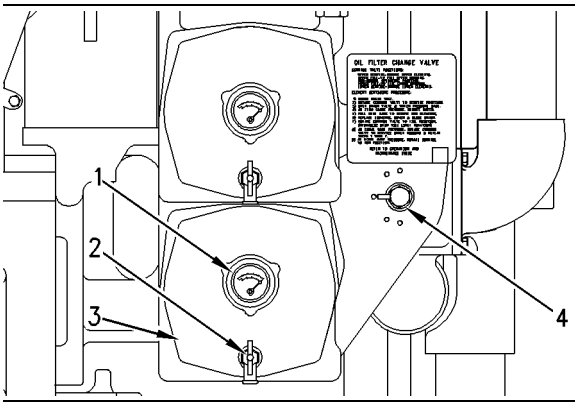


Illustration 80 g00789754

(1) Pressure gauge
(2) Drain
(3) Cover
(4) Control valve

1. Connect a hose from each drain valve (2) to a suitable container in order to catch the oil.

2. Open both drain valves (2). Allow the oil to drain.

Note: Some oil will remain in the housing after the oil has been drained. This oil will pour out of the housing when cover (3) is removed. Prepare to catch the oil in a suitable container. Clean up any spilled oil with rags. DO NOT use absorbent particles to clean up the oil.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

3. Be alert to the spring force. The cover has a spring force up to 240 N (54 lb). Gradually loosen but do not remove the last two bolts or nuts that are located at opposite ends of covers (3). Before removing the last two bolts or nuts, pry the covers loose or tap the covers with a rubber mallet in order to relieve any spring pressure.

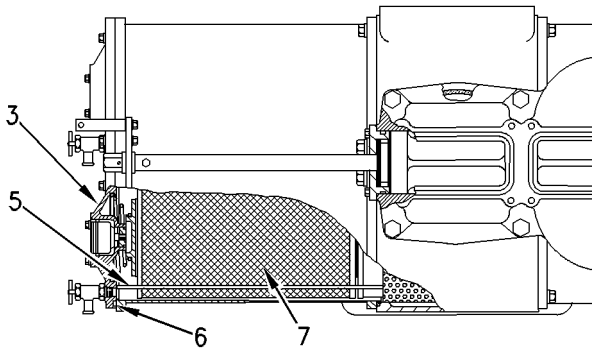


Illustration 81 g00789772

(5) Wire rack
(6) O-ring seal
(7) Element

4. Elements (7) are mounted on wire racks (5) inside the housing. Use a pan to catch the oil that drips when wire racks (5) are removed. Remove wire racks (5). Remove used elements (7). Clean up any oil that is spilled.

NOTICE

Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

5. Ensure that the new oil filter elements are in good condition. Place the elements on wire rack (5). Install the wire rack and the elements.

6. Ensure that the surfaces for O-ring seals (6) are clean. Inspect the O-ring seals. If the old O-ring seals are damaged or deteriorated, replace the old O-ring seals with new O-ring seals. Install the O-ring seals.

7. Install covers (3). Ensure that the spring is seated properly between elements (7) and covers (3). Close drain valves (2).

8. Ensure that the crankcase is filled with oil. Operate the prelube pump and rotate the control valve (if equipped) to the “FILL” position for each housing. After both of the housings are full of oil, turn the control valve (if equipped) to the “RUN” position.

9. Start the engine. Check for oil leaks.

Replacing the Engine Oil Filters During Engine Operation

⚠ WARNING

Filter contains hot pressurized fluid when engine is running.

Follow instructions on control valve to avoid personal injury.

If rapid air movement exists to blow fluid, Stop the engine to avoid fire.

If it is necessary to replace the oil filters during engine operation, perform the following procedure.

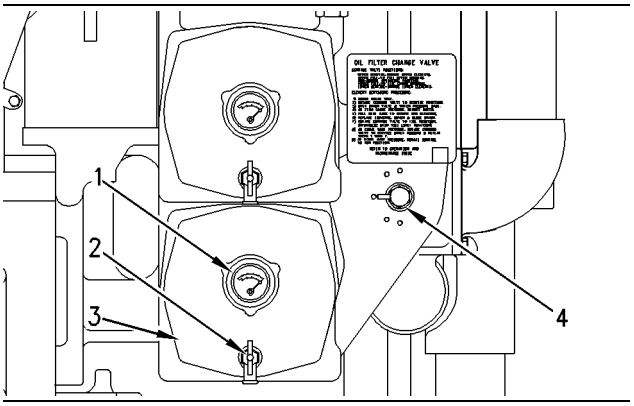


Illustration 82 g00789754

(1) Pressure gauge
(2) Drain
(3) Cover
(4) Control valve

1. Connect a hose from drain valve (2) to a suitable container in order to catch the oil.

2. Rotate control valve (4) to the “LOWER SERVICE” position.

3. Open drain valve (2) and drain the lower oil filter housing. Observe pressure gauge (1) until the pressure is “0”.

Note: Some oil will remain in the housing after the oil has been drained. This oil will pour out of the housing when cover (3) is removed. Prepare to catch the oil in a suitable container. Clean up any spilled oil with rags. DO NOT use absorbent particles to clean up the oil.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

4. After zero pressure has been reached, remove cover (3). Be alert to the spring force. The cover has a spring force up to 240 N (54 lb). Gradually loosen but do not remove the last two bolts or nuts that are located at opposite ends of cover (3). Before removing the last two bolts or nuts, pry the cover loose or tap the cover with a rubber mallet in order to relieve any spring pressure.

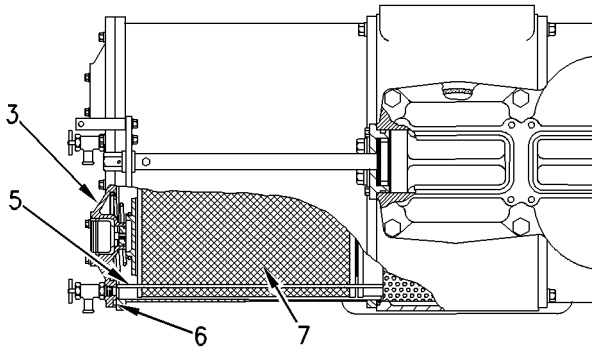


Illustration 83 g00789772

(5) Wire rack
(6) O-ring seal
(7) Element

5. Elements (7) are mounted on wire rack (5) inside the housing. Use a pan to catch the oil that drips when wire rack (5) is removed. Remove wire rack (5). Remove used elements (7). Clean up any oil that is spilled.

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

6. Ensure that the new oil filter elements are in good condition. Place the elements on wire rack (5). Install the wire rack and the elements.

7. Ensure that the surfaces for O-ring seal (6) are clean. Inspect the O-ring seal. If the old O-ring seal is damaged or deteriorated, replace the old O-ring seal with a new O-ring seal. Install the O-ring seal.

8. Install cover (3). Ensure that the spring is seated properly between element (8) and cover (3). Close drain valve (2).

9. Rotate control valve (4) to the “LOWER FILL” position. Observe pressure gauge (1). Check cover (3) for leaks.

Note: A hydraulic stop will limit the rotation of the control valve until the oil filter housing is full of oil.

10. After the pressure of the lower oil filter and the upper oil filter is equal, rotate control valve (4) to the “UPPER SERVICE” position. Repeat Step 1 through Step 9 for the upper oil filter.

11. After the oil filters have been serviced and after the pressure of the lower oil filter and the upper oil filter is equal, rotate control valve (4) to the “RUN” position.

Inspect the Used Oil Filter Elements

Cut the used oil filter element open with a utility knife. Remove the metal wrap. Cut the filter element free from the end caps. Spread apart the pleats and inspect the element for metal debris. An excessive amount of debris in the element may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the element. Ferrous metals may indicate wear on the steel and the cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, the brass parts, or the bronze parts of the engine. Parts that may be affected include the following components: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Aluminum debris may indicate problems with the bearings of the front gears. If aluminum is found in the filter, inspect the crankshaft vibration damper and the front idler gear bearing.

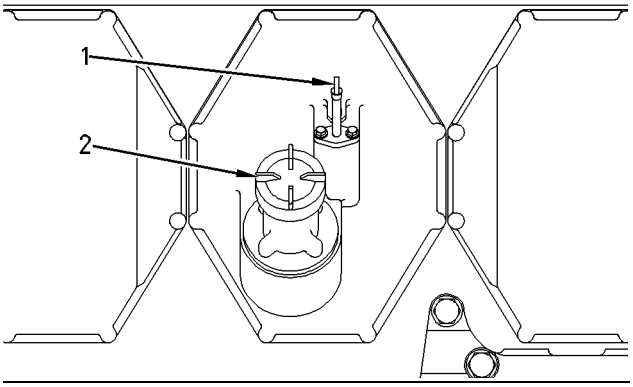
Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter element. If an excessive amount of debris is found in the oil filter element, consult your Caterpillar dealer in order to arrange for further oil analysis.

i02602034

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

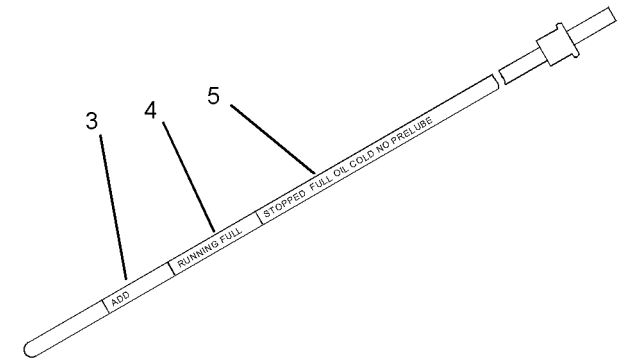
The most accurate check of the oil level is performed when the engine is stopped. Perform this maintenance on a surface that is as level as possible.



g00789822

Illustration 84

(1) Oil level gauge
(2) Oil filler



g01140702

Illustration 85

(3) “ADD” mark
(4) “RUNNING FULL” mark
(5) “STOPPED FULL OIL COLD NO PRELUBE” mark

Note: For engines with powered crankcase ventilation, remove the oil filler cap. Allow the crankcase pressure to stabilize before checking the engine oil level.

1. Ensure that oil level gauge (1) is seated.

2. Remove the oil level gauge and observe the oil level. Add engine oil if the level is in the “ADD” zone. If the engine is running, maintain the level in the “RUNNING FULL” zone.

NOTICE
Engine damage can occur if the crankcase is filled above the “FULL” mark on the oil level gauge (dipstick).

An overfull crankcase can cause the crankshaft to dip into the oil. This will reduce the power that is developed and also force air bubbles into the oil. These bubbles (foam) can cause the following problems: reduction of the oil's ability to lubricate, reduction of oil pressure, inadequate cooling, oil blowing out of the crankcase breathers, and excessive oil consumption.

Excessive oil consumption will cause deposits to form on the pistons and in the combustion chamber. Deposits in the combustion chamber lead to the following problems: guttering of the valves, packing of carbon under the piston rings, and wear of the cylinder liner.

If the oil level is above the “FULL” mark on the oil level gauge, drain some of the oil immediately.

3. If necessary, remove oil filler cap (2) and add oil. For the correct oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section). Wipe off the oil level gauge and reinstall the oil level gauge. Clean the oil filler cap and reinstall the oil filler cap.

4. Record the amount of oil that is added. For the next oil sample and analysis, include the total amount of oil that has been added since the previous sample. This will help to provide the most accurate oil analysis.

Note: Some engines are equipped with an automatic oil level controller. The oil level should still be checked on a daily basis with the oil level gauge.

i03542996

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEgj0047, “How To Take A Good S·O·S Oil Sample”. Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i00839584

Engine Oil Temperature Regulator - Replace

SMCS Code: 1330-510

The oil temperature regulators divert the engine oil to the oil cooler in order to maintain engine oil temperature.

For instructions on replacing the oil temperature regulators, see the Service Manual, “Disassembly and Assembly” module.

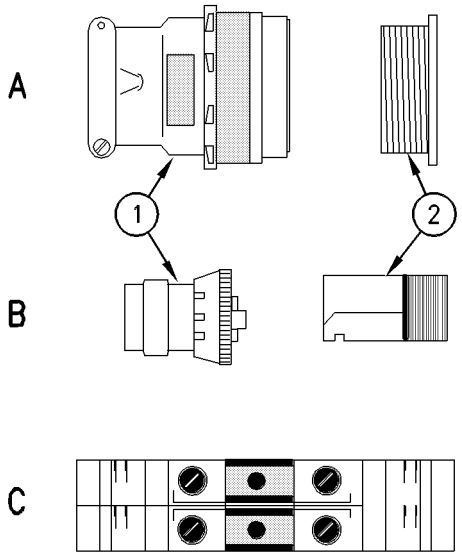
i02601497

Engine Protective Device Connections - Inspect

SMCS Code: 7400-040

Inspect the wiring and the electrical connections for these components:

- Connectors
- Control panel
- Junction box
- Sensors



g00449867

Illustration 86

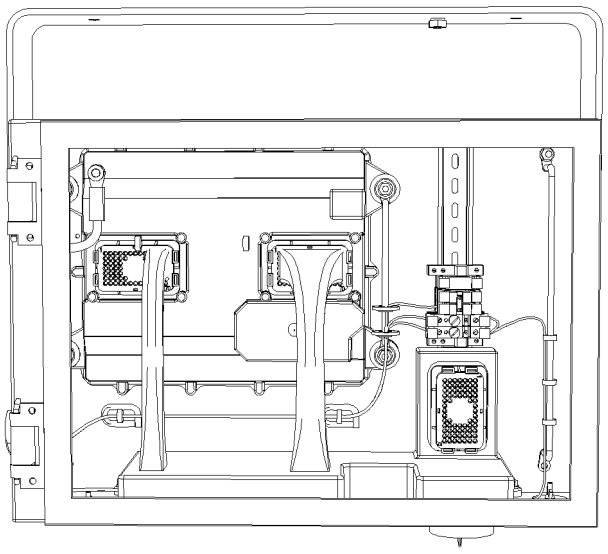
Typical examples of electrical connectors

(A) Military Standard connector
(1) Plug
(2) Receptacle
(B) Deutsch HD connector
(C) Phoenix terminal strip

Note: Military Standard (MS), Caterpillar Environmental (CE), and Vehicle Environmental (VE) connectors are similar in design. However, the wiring is soldered to the pins and sockets of Military Standard connectors. In CE and VE connectors, the wiring is crimped into the pins and sockets. The wiring is crimped into the pins and sockets of Deutsch HD connectors also.

1. Turn the mode control switch to the “OFF/RESET” position. Open the circuit breaker of the main power supply.
2. Inspect all of the wiring for the following conditions:
   - Fraying
   - Damaged insulation
   - Corrosion

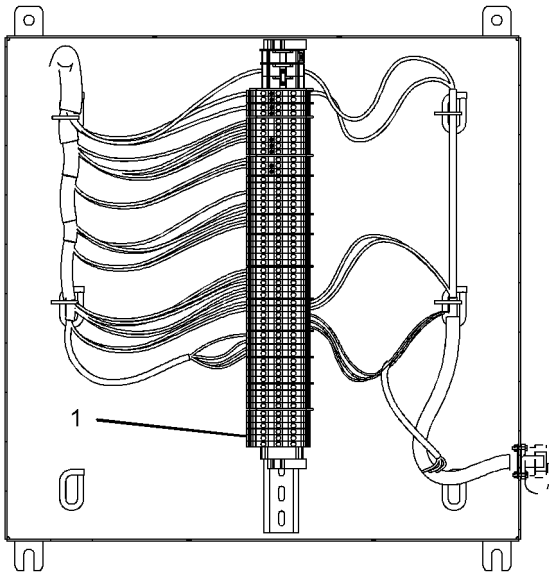
   Make repairs, as needed.



g01302112

Illustration 87

Inside of control panel (front)



g01201607

Illustration 88

Inside of control panel (rear)

(1) Terminal strips

3. Check the wiring for secure connections at these points of the junction box and the control panel:

   - Connectors
   - Relays
   - Switches
   - Terminal strips

   Perform a pull test for each wire. This test will ensure that the wiring is properly attached. Test each wire individually.

   a. Pull each wire with approximately 45 N (10 lb) of force. Pull the wire firmly.

   If a wire is loose, repair the connection. For instructions on connecting wires, see the Service Manual, “Troubleshooting” module.

4. Inspect the wiring at the relays and terminal strips for these conditions:

   - Corrosion
   - Fraying

   a. If corrosion is found, scrape large deposits. Use cotton swabs with isopropyl alcohol to clean any corrosion that remains.

   Investigate the source of the corrosion. Correct the condition.

   If damage is found, replace the part.

   b. Remove frayed strands of wire or tin the wire.

   c. Perform Steps 6 and 7 for the connectors of the control panel and the junction box.

5. Check the wiring for secure connections at these points:

   - Connectors
   - Sensors

   Perform a pull test for each wire. This test will ensure that the wiring is properly attached. Test each wire individually.

   a. For wiring that is attached to a connector, hold the body of the connector with one hand. Pull each wire with approximately 45 N (10 lb) of force. Pull the wire firmly.

   b. Before testing the wiring of the sensors, ensure that the sensors are securely installed. Then pull each wire with approximately 45 N (10 lb) of force.

   If a wire is loose, repair the connection. For instructions on connecting wires, see the Service Manual, “Troubleshooting” module.

6. Disconnect the connectors at the following locations. Inspect the connectors.

   - Engine sensors

- Junction box
- Modules of the control panel

a. Inspect each pin and each socket for corrosion and damage.

If corrosion is found, scrape large deposits. Use cotton swabs with isopropyl alcohol to clean any corrosion that remains.

Investigate the source of the corrosion. Correct the condition.

If damage is found, replace the part.

7. Reconnect the connectors.

a. For Military Standard, CE, and VE connectors, ensure the following conditions:

- The connection is threaded properly.
- The connection is threaded completely. Very little thread or no thread is visible.

b. For Deutsch HD connectors, ensure the following conditions:

- The index markings of the plug and the receptacle are aligned.
- The connection is turned fully.
- The plug and the receptacle are securely connected.

8. Close the circuit breaker of the main power supply.

i00626013

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i01762818

Engine Speed/Timing Sensor - Clean/Inspect

SMCS Code: 1905-040; 1905-070; 1907-040; 1907-070

The engine speed/timing sensor is located at the right rear side of the engine.

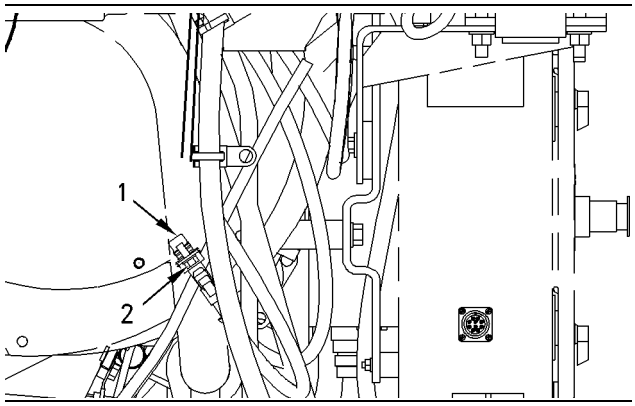


Illustration 89 g00901865

(1) Engine speed/timing sensor
(2) Bolt

1. Disconnect the wiring harness from engine speed/timing sensor (1).

2. Remove bolt (2) in order to remove engine speed/timing sensor (1).

3. Inspect the sensor for damage.

If the sensor is damaged, obtain a new sensor for installation.

4. Inspect the O-ring seal for the sensor.

   If the O-ring seal is damaged, obtain a new O-ring seal for installation.

5. Clean the tip of the sensor.

Note: The engine speed/timing sensor does not require any special adjustments.

6. Install the sensor. Make sure that the sensor is properly seated. Tighten bolt (2).

7. Inspect the wiring harness. Make sure that the connector is in good condition. Attach the wiring harness to the sensor. Make sure that the mating of the connectors is proper.

i01765700

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

For instructions on the following procedures, refer to Systems Operation/Testing and Adjusting. Consult your Caterpillar dealer for assistance.

Note: Use of a platform may be necessary for these procedures.

Check the Timing of the Crankshaft and Camshaft

The timing of the crankshaft and camshaft must be checked, and the valve bridge must be adjusted before the valve lash is adjusted.

NOTICE
If the camshaft is rotated with the timing pin installed, the timing pin will break. This can result in further damage. Make sure to remove the timing pin before the camshaft is rotated.

NOTICE
DO NOT use the starting motor to rotate the crankshaft. The lubrication oil can drain out from between the crankshaft and the engine bearings if the engine has not been operated for a period of time. Damage can result if the crankshaft is rotated on dry bearing surfaces.

To prevent damage to the crankshaft bearings, DO NOT crank the engine before prelube, especially after this maintenance procedure.

NOTICE
The prelube pump should not be operated continuously for extended periods of time. If, during repairs, the prelube pump has run continuously for a period of three hours or more, it will be necessary to remove any oil that may have collected in the cylinders and/or above the valves.

Prelube of the engine is required before the crankshaft is rotated for normal maintenance. Activate the prelube pump for rotating the engine crankshaft.

NOTICE
Do not use an impact wrench to operate the barring device. The use of an impact wrench will cause gear tooth failure.

The barring device provides a means for slowly turning the flywheel in order to service the engine. The barring device can also be used to prevent rotation of the crankshaft.

Valve Bridge

NOTICE
Do NOT attempt to adjust the valves if the crankshaft and camshaft are not synchronized. Disregard for this can result in engine damage such as bent valves.

Check the valve bridges. Perform the procedure for both valve bridges for each cylinder.

After the valve bridge is checked for each cylinder, check the valve lash for the exhaust valves, the inlet valves, and the gas admission valves.

Engine Valve Lash

If the valve lash is within the tolerance, an adjustment of the valve lash is NOT necessary.

The crankshaft and camshaft timing must be checked, and valve bridge adjustment must be performed before making a valve lash adjustment.

Perform the valve lash setting when the engine is cold. After the engine has been shut down and the valve covers are removed, the engine is considered cold.

Before performing maintenance, prevent the entry of foreign matter into the top of the cylinder head and the valve mechanism. Thoroughly clean the area around the valve mechanism covers.

Gas Admission Valve

Check the valve lash for the gas admission valve when the valve lash for the inlet valves and exhaust valves are checked. Adjust the valve lash for the gas admission valves, if necessary.

i01765711

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

NOTICE
A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Note: Use of a platform may be necessary to reach the engine valve rotators.

Perform this procedure after the valve lash has been set.

1. Mark the tops of the valve rotators with a permanent marker. Note the position of the marks.
2. Install the valve covers. See the Service Manual for the procedure.
3. Start the engine. Operate the engine for 5 minutes. Stop the engine.
4. Remove the valve covers. Observe the position of the marks that are on the valve rotators.

If a valve fails to rotate, consult your Caterpillar dealer.

i01765718

Exhaust Bypass - Recondition

SMCS Code: 1057-020

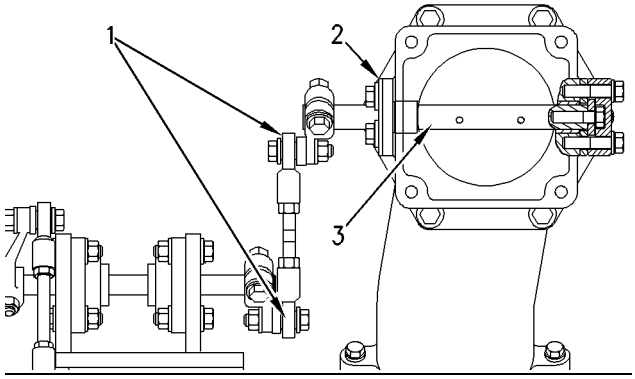


Illustration 90 g00799396

Typical example

(1) Rod ends
(2) Cover and seal
(3) Shaft

Note: Use of a platform may be necessary in order to reach the components of the exhaust bypass.

Replace the following parts:

- Rod ends (1)
- Cover and seal (2)
- Shaft (3)

For instructions on assembling the exhaust bypass, refer to the Specifications.

i00457458

Exhaust Shields - Inspect

SMCS Code: 1067-040

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
The exhaust shields can be damaged if work is performed on the exhaust shields or around the exhaust shields.

Remove the exhaust shields or protect the exhaust shields before performing work on the exhaust shields or around the exhaust shields. Handle the exhaust shields carefully.

Do not tear the foil that is inside of the exhaust shields. Torn foil will allow the insulation to absorb flammable liquids and a fire can result from engine heat.

Ensure that the exhaust manifold is cool. Inspect the exhaust shields. Replace any exhaust shield that is damaged. Refer to the Service Manual for the procedure to remove the exhaust shields and install the exhaust shields.

i02602064

Fuel System Fuel Filter Differential Pressure - Check

SMCS Code: 1261-535

If the engine is equipped with a fuel filter, a fuel filter differential pressure gauge must be installed. The fuel filter differential pressure gauge is installed in order to determine when the fuel filter requires service. This gauge and the fuel filter are supplied by the customer.

A fuel filter differential pressure gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. The differential pressure increases as the fuel filter becomes plugged.

Operate the engine with a full load at the rated rpm and at the normal operating temperature. Check the fuel filter differential pressure at full load.

Service the fuel filter when the fuel filter differential pressure reaches 1.7 kPa (0.25 psi).

For instructions, refer to Special Instruction, SEHS9298, “Installation and Maintenance of Gaseous Fuel Filters”. Consult your Caterpillar dealer for assistance.

i01765725

Gas Admission Valve - Recondition

SMCS Code: 1105-020-GS

Note: Use of a platform may be necessary to reach the gas admission valves.

For the procedure to remove the gas admission valve, refer to the engine's Disassembly and Assembly.

When you disassemble the gas admission valve, inspect the seals. Replace the seals, if necessary. Refer to this Operation and Maintenance Manual, “Gas Admission Valve Seals - Inspect/Replace”.

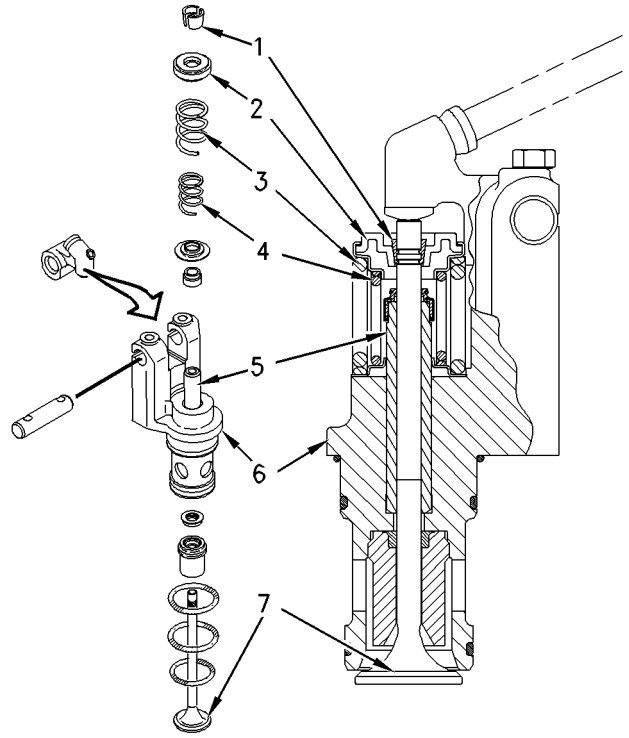


Illustration 91 g00833978

Exploded view and section view of the parts for the gas admission valve

(1) Retainer locks
(2) Valve rotator
(3) Outer valve spring
(4) Inner valve spring
(5) Valve guide
(6) Support assembly
(7) Valve

To recondition the gas admission valve, replace retainer locks (1), valve rotator (2), outer valve spring (3), inner valve spring (4), and valve (7).

Valve guide (5) will probably have very little wear. However, measure the inner diameter of the valve guide at both ends and the middle. The maximum allowable inner diameter of the valve guide at both ends and the middle is 9.538 mm (0.3755 inch). If any measurement exceeds this specification, replace the valve guide. If this is not possible, replace support assembly (6) and the valve guide.

It is unlikely for support assembly (6) to require replacement. However, inspect the valve seat in the support assembly.

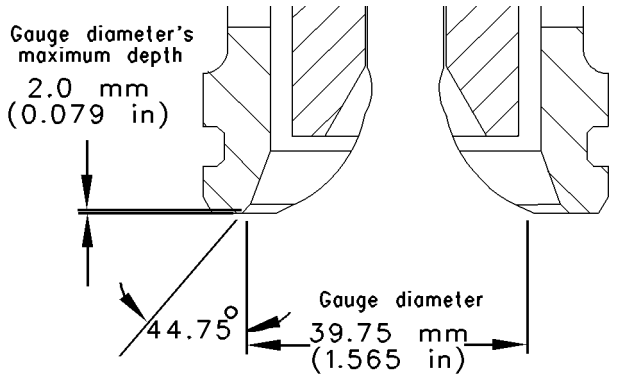


Illustration 92 g00833994

Angle and dimensions for the valve seat in the support assembly

If the valve seat is worn, the valve seat can be slightly ground according to these specifications:

- The angle for the valve seat is 44.75 ± 0.5 degrees.
- The gauge diameter of the valve seat within a maximum depth of 2.0 mm (0.079 inch) from the end of the support assembly is 39.75 mm (1.565 inch).

Use some Prussian blue to verify complete contact of the valve in the valve seat.

i01765734

Gas Admission Valve Seals - Inspect/Replace

SMCS Code: 1105-040-GS; 1105-510-GS

The camshaft operates the mechanism for the gas admission valve in order to allow fuel to enter the inlet port of the cylinder.

Note: Use of a platform may be necessary to reach the gas admission valves.

For the procedure to remove the gas admission valve, refer to the engine's Disassembly and Assembly.

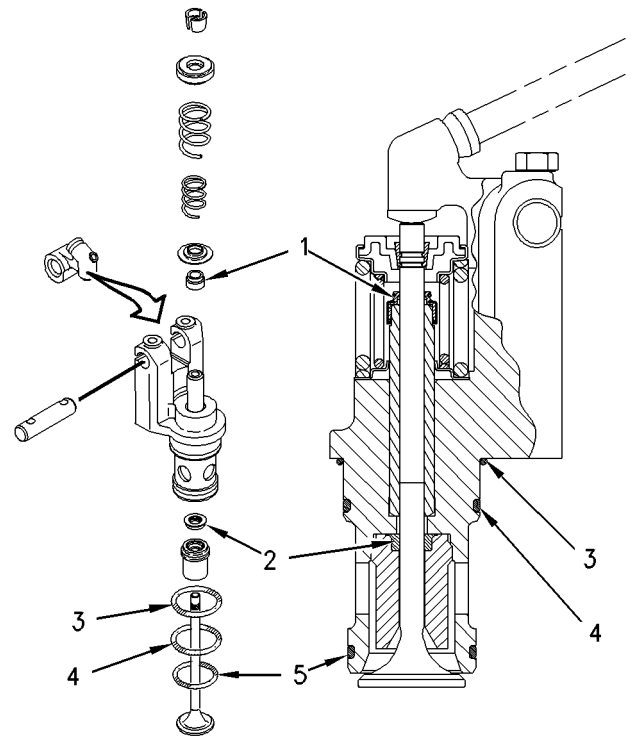


Illustration 93 g00833829

Exploded view and section view of the parts for the gas admission valve

(1) Upper valve stem seal
(2) Lower valve stem seal
(3, 4, and 5) O-ring seals for the support assembly

Note: The portion of the valve stem in lower valve stem seal (2) may be slightly worn. This shallow wear does not affect the performance of the gas admission valve.

Inspect valve stem seals (1) and (2). Inspect O-ring seals (3), (4), and (5). Replace the seals, if necessary.

i00679524

Gas Pressure Regulator - Inspect/Replace

SMCS Code: 1550-040; 1550-510

Inspect the gas pressure regulator for the following conditions:

- Wear
- Cracks
- Pin holes
- Improper operation

If any of those conditions are found, the gas pressure regulator must be repaired or replaced.

For information on replacing the gas pressure regulator, see the Service Manual. Consult your Caterpillar dealer for assistance.

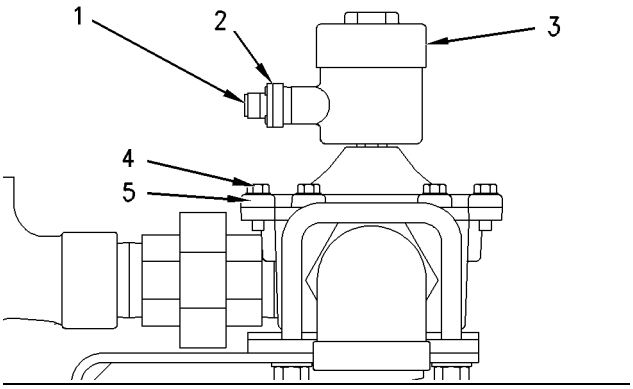
i01611465

Gas Shutoff Valve - Inspect

SMCS Code: 1329-040

The gas shutoff valve (GSOV) has a solenoid that is operated with 24 VDC. When power is supplied to the solenoid, fuel flows through the GSOV to the engine. When the power is interrupted, the gas is shut off.

1. Shut off the engine.
2. Shut off the fuel supply to the GSOV.



g00834076

Illustration 94

(1) Receptacle
(2) Gasket
(3) Cap
(4) Bolt
(5) Cover

3. Disconnect the wiring harness from receptacle (1). Inspect the connectors for damage and corrosion. Make repairs, as needed.
4. Inspect gasket (2) for damage and wear. Replace the gasket, if necessary.
5. Remove cap (3). Remove the washer under the cap in order to inspect the solenoid.
6. Inspect the solenoid for damage. If the epoxy coating is cracked or damaged, obtain a new solenoid for assembly.
7. Inspect the cavity for the solenoid. Look for moisture, debris, and abrasion of the wiring. Make repairs, if necessary. Thoroughly clean the cavity.
8. Remove bolts (4) and cover (5) in order to inspect the internal parts of the GSOV.
9. Clean the internal parts. Inspect the diaphragm, the center pin for the diaphragm, and the shaft for the solenoid. If any of the parts are damaged, replace the entire GSOV.
10. Inspect the internal passages. Remove any debris.
11. Reassemble the diaphragm, the center pin for the diaphragm, and the shaft for the solenoid. Install cover (5) with bolts (4).
12. Install cap (3). Connect the wiring harness to receptacle (1).
13. Turn on the fuel supply to the GSOV. Use a gas detector to check for gas leaks.

i03847809

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Hoses and clamps must be inspected periodically in order to ensure safe operation and continuous operation of the engine. Take proper safety precautions before inspecting or replacing hoses and clamps.

Note: Always use a board or cardboard when the engine components are checked for leaks. Leaking fluid that is under pressure can cause serious injury or possible death. This includes leaks that are the size of a pin hole. Refer to Operation and Maintenance Manual, “General Hazard Information” for more information.

Inspect the Hoses and the Clamps

Inspect all hoses for leaks that are caused by the following conditions. Replace any hose which exhibits any of the following conditions. Failure to replace a hose which exhibits any of the following conditions may result in a hazardous situation.

- Hoses which are cracked
- Hoses which are soft
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally

- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering
- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

Inspect all clamps for the following conditions. Replace any clamp which exhibits signs of any of the following conditions.

- Cracking
- Looseness
- Damage

Inspect all couplings for leaks. Replace any coupling which exhibits signs of leaks.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Replace hoses that are cracked or soft. Replace hoses that show signs of leakage. Replace hoses that show signs of damage. Replace hose clamps that are cracked or damaged. Tighten or replace hose clamps which are loose.

Replace the Hoses and the Clamps

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Caterpillar Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Cooling System

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Stop the engine.
2. Allow the engine to cool.
3. Before servicing a coolant hose, slowly loosen the filler cap for the cooling system in order to relieve any pressure.
4. Remove the filler cap for the cooling system.
5. Drain the coolant from the cooling system to a level that is below the hose that is being replaced. Drain the coolant into a suitable clean container. The coolant can be reused.
6. Remove the hose clamps.

7. Disconnect the old hose.

8. Replace the old hose with a new hose.

9. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

10. Refill the cooling system.

11. Clean the filler cap for the cooling system. Inspect the gaskets on the filler cap. Replace the filler cap if the gaskets are damaged. Install the filler cap.

12. Start the engine. Inspect the cooling system for leaks.

Fuel System

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Note: High pressure fuel lines may be installed between the high pressure fuel pump and the fuel injectors. High pressure fuel lines are constantly charged with high pressure. Do not check the high pressure fuel lines with the engine or the starting motor in operation. Wait for 10 minutes after the engine stops before you perform any service or repair on high pressure fuel lines in order to allow pressure to be purged.

1. Drain the fuel from the fuel system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

7. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

8. Start the engine. Inspect the fuel system for leaks.

Lubrication System

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

1. Drain the oil from the lubrication system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Refill the lubrication system. Refer to this Operation and Maintenance Manual, “Engine Oil Level - Check” in order to ensure that the lubrication system is filled with the proper amount of engine oil.

7. Start the engine. Inspect the lubrication system for leaks.

Air System

1. Remove the hose clamps.

2. Disconnect the old hose.

3. Replace the old hose with a new hose.

4. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications”, “Hose Clamps” for information about selecting and installing the proper hose clamps.

5. Start the engine. Inspect the air lines for leaks.

i03915150

Ignition System Spark Plugs - Check/Adjust

SMCS Code: 1555-535

Maintenance of the spark plugs is required in order to obtain the following benefits:

- Normal fuel consumption
- Normal levels of emissions
- Maximum service life of the spark plugs

The service life of the spark plugs is affected by fouling due to deposits from the oil and by peak voltage. Maintenance of the ignition system is also affected by voltage. Higher voltage is required by higher inlet manifold air pressure and a higher compression ratio. Higher voltage reduces the service life of components such as spark plug wires and transformers.

Removing the Spark Plug

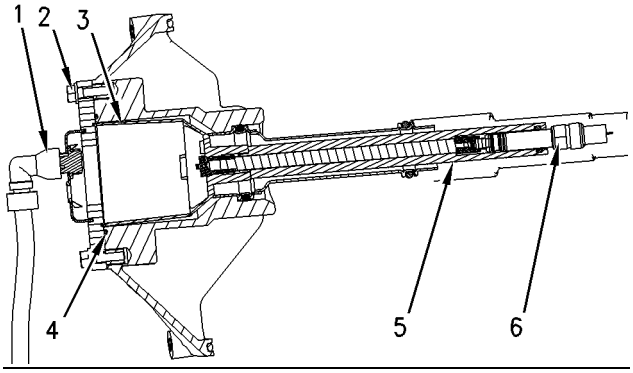


Illustration 95 g00823378

(1) Harness connector
(2) Bolt
(3) Transformer
(4) O-ring seal
(5) Extension
(6) Spark plug

1. Ensure that the mode control switch is in the “STOP” or “OFF/RESET” position.

NOTICE
Pulling on the wiring harness may break the wires. Do not pull on the wiring harness.

2. Remove the lockwire. Disconnect harness connector (1). Use pliers to turn the connector counterclockwise.

3. Remove bolts (2).

4. Remove transformer (3). Inspect O-ring seal (4). If the O-ring seal is worn or damaged, discard the O-ring seal and use a new O-ring seal for assembly.

5. Remove extension (5).

⚠ WARNING

Pressurized air can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing, and protective shoes.

6. Debris may have collected near the spark plug. Thoroughly remove any debris. Use compressed air. The maximum air pressure for cleaning purposes must be below 207 kPa (30 psi). Ensure that the area around the spark plug is clean and free of dirt and debris.

7. Use a 4C-4601 Spark Plug Socket and an extension to loosen spark plug (6). After the spark plug has been loosened, remove the spark plug by hand in order to detect problems with the threads. After the spark plug has been removed, discard the used gasket.

NOTICE
The use of a thread tap will remove metal unnecessarily. This will also reduce the heat transfer for the spark plug. This can result in a reduction of the spark plug service life and a reduction of the detonation margin.

If the spark plug resists removal by hand, apply penetrating oil to the threads. Use the wrench and apply steady pressure to the spark plug until the spark plug is loose.

If the spark plug cannot be removed by hand, clean the threads with 9U-7511 Spark Plug Seat Cleaner. This tool scrapes debris from the seat and from the threads.

Inspecting the Spark Plug

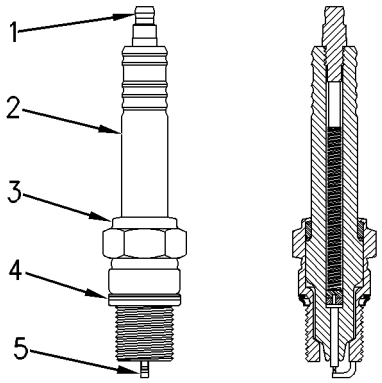


Illustration 96 g00838300

(1) Terminal post
(2) Insulator
(3) Shell
(4) Gasket
(5) Electrode

Inspect the spark plug closely for damage. The condition of the spark plug can indicate the operating condition of the engine.

Terminal post (1) must not move. If the terminal post can be moved by hand, discard the spark plug.

Inspect insulator (2) for cracks. If a crack is found, discard the spark plug.

Faint marks may extend from shell (3) onto the insulator. The marks may be a result of corona that forms at the top of the shell. The corona develops when a high voltage potential ionizes the air that surrounds a conductor, which is a normal condition. This condition is not an indication of leakage between the shell and the insulator.

Inspect shell (3) for damage. Cracks can be caused by overtightening the spark plug. Overtightening can also loosen the shell. Discard any spark plug that has a shell that is cracked or loose.

Inspect electrode (5) for excessive wear. Flat surfaces with sharp edges provide the best conditions for creating a spark. An electrode will become worn from use. The surfaces erode. A higher voltage is required in order to produce a spark.

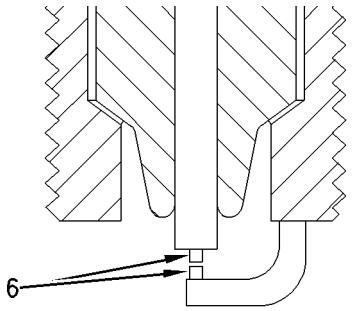


Illustration 97 g00760569

(6) Precious metal pads on the electrode and the ground strap

Caterpillar spark plugs have precious metal pads (6) on the tips of the electrode and the ground strap. This material will gradually erode.

Replace the spark plug if the precious metal is worn off.

Light brown deposits or beige deposits around the electrode are produced by normal operation. White deposits or gray deposits may be caused by the following substances:

- Excessive oil
- Use of the wrong oil
- A substance that is introduced through the fuel system or the air system

A spark plug can operate despite a buildup of ash. However, a buildup of ash can cover the electrode gap. The buildup will cause misfire. Large deposits may retain heat which can cause premature fuel ignition. Premature fuel ignition can lead to uncontrollable detonation.

Cleaning the Spark Plug

Thoroughly clean the spark plug. Do not use a wire brush. Glass beads are the preferred method for cleaning.

Follow these guidelines for using glass beads:

- Always use clean glass beads.
- Use care in order to clean only the electrode and the insulator near the electrode.
- Do not use glass beads on the outside of the shell or on the upper part of the insulator.

Installing the Spark Plug

Note: Use the 9U-7516 Spark Plug Gauge to measure the electrode gap. Do not use a flat feeler gauge for measuring the electrode gap of used spark plugs. A feeler gauge will produce a false measurement because the used precious metal surfaces will be curved.

1. Before installing the spark plug, set the electrode gap to 0.29 ± 0.03 mm (.011 ± 0.001 inch).

   Adjust the electrode gap by bending the ground electrode at the existing bend. Then bend the strap near the weld in order to achieve proper alignment and even spacing between the two precious metal surfaces. Measure the electrode gap after the alignment. Correct the electrode gap, if necessary.

Note: Do not use anti-seize compound on spark plugs. Most of the heat is transferred through the threads and the seat area of the spark plug. The surfaces must be in contact in order to provide the heat transfer that is required.

2. Ensure that the spark plug is clean and free of dirt and oil.

3. Always use a new gasket when a spark plug is installed. If a used spark plug is installed, place a new 9Y-6792 Gasket on the spark plug. Orient the tabs of the gasket toward the electrode. Otherwise, the gasket may not seat properly. If a gasket for a spark plug is installed incorrectly, do not increase the torque on the spark plug in order to improve the seal. Do not reuse the gasket. Install a new gasket.

NOTICE

Do not overtighten the spark plug. The shell can be cracked and the gasket can be deformed. The metal can deform and the gasket can be damaged. The shell can be stretched. This will loosen the seal that is between the shell and the insulator, allowing combustion pressure to blow past the seal. Serious damage to the engine can occur.

Use the proper torque.

4. Install the spark plug by hand until the spark plug bottoms out. For the 301-6663 Spark Plug, tighten the spark plug to 48 ± 5 N·m (35 ± 4 lb ft). For the 243-4291 Spark Plug, tighten the spark plug to 45 ± 5 N·m (33 ± 3 lb ft).

5. Inspect the extension and clean the extension.

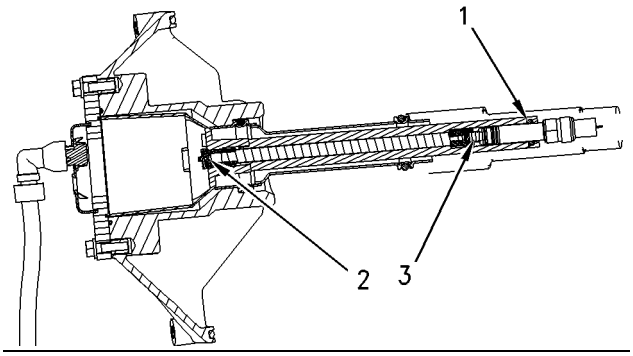


Illustration 98 g00823413

(1) O-ring seal
(2) Connection of the extension and the transformer
(3) Connection of the extension and the spark plug

   a. Inspect O-ring seal (1). If the O-ring seal is hard, cracked, or melted, use a new O-ring seal for assembly.

   b. Use a mild abrasive cleaner to clean deposits and/or corrosion from the extension at connection points (2) and (3).

   c. Apply one of the following lubricants to O-ring seal (1) and to the extension at connection points (2) and (3):

      - 4C-9504 Dielectric Grease
      - 8T-9020 Dielectric Grease

      This lubricant will help to protect the connection points of the extension from corrosion.

6. Ensure that the internal spring exerts force on the connection points. Install the extension onto the spark plug.

7. Ensure that the transformer assembly is clean and free of dirt and oil. Assemble the extension into the transformer. Install the transformer.

8. Connect the wiring harness. Tighten the connector clockwise with pliers until the connector cannot be loosened by hand. Replace the lockwire.

i01612988

Ignition System Spark Plugs - Replace

SMCS Code: 1555-510

Remove the used spark plugs. Install new spark plugs.

For instructions on removing and installing spark plugs, refer to this Operation and Maintenance Manual, “Ignition System Spark Plugs - Check/Adjust” topic (Maintenance Section).

i01935380

Inlet Air System - Inspect

SMCS Code: 1058-040; 1071-040; 1087-040

Use of a platform may be necessary to inspect the following components of the air inlet system:

- Piping between the air cleaner and the turbocharger
- Rubber hoses in the air lines
- Turbocharger
- Piping between the turbocharger and the aftercooler
- Aftercooler
- Connection of the aftercooler to the air plenum
- Connection of the air plenum to the cylinder head

Inspect the components for the following conditions:

- Cracks
- Leaks
- Loose connections
- Debris

Ensure that all of the connections are secure. Ensure that the components are in good condition and free of debris.

Make repairs, if necessary. For information regarding removal and installation of the components, refer to Service Manual, “Disassembly and Assembly”. Consult your Caterpillar dealer for assistance.

i00683392

Inlet Gas Manifold and Piping - Inspect/Replace

SMCS Code: 1550-040; 1550-510

Inspect the components of the fuel inlet system for the following conditions:

- Cracks
- Deterioration
- Leaks
- Loose connections
- Wear

Inspect the following components:

- Fuel lines from the source to the gas regulator
- Fuel lines from the gas regulator to the fuel inlet
- Fuel inlet
- Control valve
- Fuel manifold
- Connections of the fuel manifold and the fuel lines
- Connections of the fuel lines to the orifice
- Connections of the fuel lines to the cylinder head
- Connections of the fuel lines to the precombustion chamber
- Fuel pressure sensor
- Fuel temperature sensor

Ensure that all of the connections are secure. Ensure that the components of the fuel system are in good condition.

Make repairs, if necessary. For information regarding removal and installation of the components, see the Service Manual. Consult your Caterpillar dealer for assistance.

i02252012

Overhaul (In-Frame)

SMCS Code: 1000-020

Scheduling an In-Frame Overhaul

Table 37 lists the approximate number of service hours before an in-frame overhaul for different G3600 Engine applications.

Table 37

Estimated Service Hours Before An In-Frame Overhaul		
Fuel	**Compression Ratio**	**Service Hours**
Wellhead gas or natural gas	9.2:1	50000
Natural gas	10.5:1	45000 to 48000
Bio-gas	9.2:1	27000 to 33000

Scheduling an in-frame overhaul normally depends on the following three conditions:

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease and a variation of cylinder compression

Each individual condition may not indicate a need for an overhaul. However, evaluating the three conditions together is the most accurate method of determining when an overhaul is necessary.

The engine may not require an overhaul if the engine is operating within acceptable limits for oil consumption, crankcase blowby, and cylinder compression.

Periodically measure each of the three conditions. The first measurement should occur during the first scheduled maintenance. This establishes a baseline for future measurements. Additional measurements are scheduled at regular intervals in order to determine a schedule for the next in-frame overhaul.

The following changes in the three conditions normally require a scheduled overhaul:

- A 300 percent increase in oil consumption
- A 200 percent increase in crankcase blowby
- A 20 percent loss of cylinder compression

Note: These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

An in-frame overhaul does not typically require the engine to be removed. Instead, the service is performed with the engine in place.

Note: The generator or the driven equipment may also require service when the engine overhaul is performed.

In-Frame Overhaul Information

An in-frame overhaul includes all of the work that is done for a top end overhaul. Additionally, some other components that wear are replaced. The condition of components is inspected. Those components are replaced, if necessary.

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the following recommendations.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component can be reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Various worn components may be exchanged with your Caterpillar dealer. Consult your Caterpillar dealer about repair options for your engine.

Table 38

In-Frame Overhaul (1)	
Procedure	**Component**
Inspect Replace	Aftercooler
	Cylinder liners
	Oil cooler
	Pistons
Rebuild	Gas admission valve
	Electrohydraulic actuators
	Vibration damper
Replace	Camshaft bearings
	Camshaft followers
	Connecting rod bearings
	Crankshaft seals
	Engine oil pump
	Exhaust shields
	Gaskets and seals
	Electrohydraulic system's oil pump
	Main bearings
	Oil temperature regulators
	Piston rings
	Prechamber assemblies
	Water pumps
	Water temperature regulators

(1) In addition to these procedures, perform the procedures for the top end overhaul.

i02252260

Overhaul (Major)

SMCS Code: 7595-020-MJ

Scheduling a Major Overhaul

Table 39 lists the approximate number of service hours before a major overhaul for different G3600 Engine applications.

Table 39

Estimated Service Hours Before a Major Overhaul		
Fuel	**Compression Ratio**	**Service Hours**
Wellhead gas or natural gas	9.2:1	100000
Natural gas	10.5:1	75000 to 80000
Bio-gas	9.2:1	52000 to 54000

The need for a major overhaul is determined by several factors:

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease and variation of cylinder compression

The following changes in the three conditions normally require a scheduled overhaul:

- A 300 percent increase in oil consumption
- A 200 percent increase in crankcase blowby
- A 20 percent loss of cylinder compression

Note: These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

The engine does not require an overhaul if the engine is operating within acceptable limits for oil consumption, crankcase blowby, and cylinder compression.

Other factors must also be considered for determining a major overhaul:

- The service hours of the engine
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

Note: It is possible for oil analysis to indicate a decrease of wear metals in the lube oil. The cylinder liners may be worn so that polishing of the bore occurs. Also, the increased use of lube oil will dilute the wear metals.

Monitor the engine as the engine accumulates service hours. Consult your Caterpillar dealer about scheduling a major overhaul.

Note: The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

Major Overhaul Information

A major overhaul includes all of the work that is done for a top end overhaul. A major overhaul can also include all of the work that is done for an in-frame overhaul. A major overhaul includes additional parts and labor. Additional parts and labor may be required in order to completely rebuild the engine. In some cases, the engine is relocated for disassembly.

For the major overhaul, bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced with a Caterpillar replacement part.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the following recommendations.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component can be reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer. Consult your Caterpillar dealer about repair options for your engine.

Table 40

Major Overhaul[1]	
Procedure	**Component**
Inspect Replace	Camshafts
	Connecting rods
	Crankshaft
Rebuild	Inlet air piping
Replace	Aftercooler
	Camshaft lifters
	Exhaust manifolds
	Gear train bearings
	Oil cooler

(1) In addition to these procedures, perform the procedures for both the top end overhaul and the in-frame overhaul.

i03247357

Overhaul (Top End)

SMCS Code: 7595-020-TE

Scheduling a Top End Overhaul

Table 41 lists the approximate number of service hours before a top end overhaul for different G3600 Engine applications.

Table 41

Estimated Service Hours Before a Top End Overhaul		
Fuel	**Compression Ratio**	**Service Hours**
Wellhead gas or natural gas	9.2:1	25000
Natural gas	10.5:1	15000
Bio-gas	9.2:1	10000 to 14000

Top end overhauls are normally scheduled according to the projection of exhaust valve stems. This measurement provides an accurate indication of the rate of valve wear. This measurement can be used to predict when a cylinder head requires replacement.

Measure the projection of the exhaust valve stems at the first 1000 service hours. This measurement is the baseline. The baseline is a reference for subsequent measurements. Continue to periodically measure the projection.

Plan for the top end overhaul as the valve stem projection approaches the maximum limit. Perform the top end overhaul when the valve stem projection has increased by a total of 2.3 mm (.09 inch). **Do not allow the projection of the exhaust valve stems to exceed this limit.**

Note: Generally, cylinder heads wear out at different rates. In some cases, servicing the cylinder heads at different times may be the most economic decision. This depends on the valve stem projection of the individual cylinders. However, this decision must include the costs of additional downtime that is caused by this procedure. Perform an economic analysis in order to determine if cylinder heads should be serviced as a group or divided into smaller groups.

Note: The generator or the driven equipment may also require service when the engine overhaul is performed.

Top End Overhaul Information

A top end overhaul involves servicing the cylinder heads and turbochargers. Also, some other engine components are inspected.

Top end overhauls require more tools than preventive maintenance. The following tools are needed for restoring the engine to factory specifications:

- Torque wrenches
- Dial indicators
- Accurate measurement tools
- Cleaning equipment
- Rebuilding equipment

Caterpillar dealers are equipped with these tools. Caterpillar dealers can provide a flat rate price for a top end overhaul.

Unexpected problems may be found during a top end overhaul. Plan to correct these problems, if necessary.

- Buildup in the cylinders from excessive oil consumption
- Plugging of the aftercooler from coolant that is poorly maintained
- Degradation of the oil cooler from hydrogen sulfide in the fuel

Inspect the following components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the following recommendations.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component can be reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a Cat remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer. Consult your Caterpillar dealer about repair options for your engine.

Table 42

Top End Overhaul	
Procedure	**Component**
Inspect/Replace	Seals for the gas admission valve Precombustion chambers Drive coupling
Rebuild	Gas pressure regulator Starting motor Turbochargers
Replace	Connecting rod bearings Cylinder heads and gaskets Oil temperature regulators Spark plug extenders Water temperature regulators

i02250409

Overhaul Considerations

SMCS Code: 7595-043

Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts that are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block

Most owners will save money by overhauling the engine at the intervals that are recommended in the Operation and Maintenance Manual. It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

Overhaul Intervals

Top end overhauls are determined by the projection of exhaust valve stems. In-frame overhauls are determined by cylinder compression, crankcase blowby, and oil consumption. Major overhauls are determined by the in-frame tests, and by results of S·O·S oil analysis.

Some other factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels
- Proper installation
- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed

Note: To avoid oil problems, engines that are turbocharged and aftercooled must be operated at a minimum of 60 percent of rated load.

Generally, engines that are operated at a reduced load and/or speed achieve more service life before an overhaul. However, this is for engines that are properly operated and maintained.

Bio-Gas

The overhaul intervals for engines that use bio-gas depend on the concentration of contaminants in the fuel. Although silicon is the primary contaminant in bio-gas, other contaminants may cause further reductions in the overhaul intervals. For more information, refer to Gas Engines Application and Installation Guide, LEKQ7260, “G3600 - G3300 Low Energy Fuels”.

Overhaul Inspection

Refer to the Service Manual for the disassembly and assembly procedures that are necessary in order to perform the required maintenance on the items that are listed. Consult your Caterpillar dealer for assistance.

To determine the reusability publications that are needed to inspect the engine, refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”.

The Guidelines For Reusable Parts and Salvage Operations is part of an established Caterpillar parts reusability program. These guidelines were developed in order to assist Caterpillar dealers and customers reduce costs by avoiding unnecessary expenditures for new parts. If the engine parts comply with the established inspection specifications, the parts can be reused. New parts are not necessary if the old parts can be reused, repaired, or salvaged.

If the parts are not within the inspection specifications, the parts should be salvaged, repaired, replaced, or exchanged. The use of out-of-spec parts could result in unscheduled downtime and/or costly repairs. The use of out-of-spec parts can also contribute to increased fuel consumption and reduction of engine efficiency.

Your Caterpillar dealer can provide the parts that are needed to rebuild the engine at the least possible cost.

Overhaul Programs

An economical way to obtain most of the parts that are needed for overhauls is to use Caterpillar remanufactured parts. Caterpillar remanufactured parts are available at a fraction of the cost of new parts. These parts have been rebuilt by Caterpillar and certified for use. The following components are examples of the remanufactured parts:

- Alternators
- Connecting rods
- Crankshafts
- Cylinder heads
- Oil Pumps
- Starting motors
- Turbochargers
- Water pumps

Consult your Caterpillar dealer for details and for a list of the remanufactured parts that are available.

Your Caterpillar dealer may be offering a variety of overhaul options.

A Flat Rate Overhaul guarantees the maximum price that you will pay for an overhaul. Flat rate prices on preventive maintenance programs or major repair options are available from many servicing dealers for all Caterpillar Engines. Consult your Caterpillar dealer in order to schedule a before failure overhaul.

Overhaul Recommendation

Caterpillar recommends a scheduled overhaul in order to minimize downtime. A scheduled overhaul will provide the lowest cost and the greatest value. Schedule an overhaul with your Caterpillar dealer.

Overhaul programs vary between dealers. To obtain specific information about the types of overhaul programs and services, consult your Caterpillar dealer.

i02602727

Prechamber - Clean/Inspect

SMCS Code: 1106-571

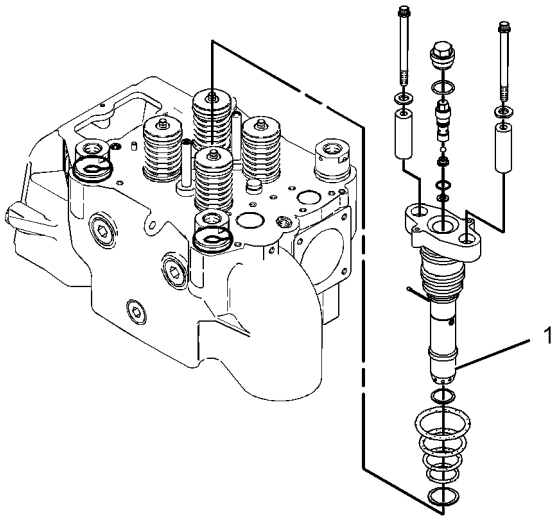


Illustration 99 g01302648

1. Remove the ignition body assembly. Remove prechamber cup (1) from the ignition body. Refer to the engine's Disassembly and Assembly manual for instructions.
2. Clean the deposits from the prechamber cup.
3. Inspect the sealing flange for damage and debris. Replace any prechamber cup that has a damaged flange. Replace any prechamber cup that has eroded holes. Replace any prechamber cup that has cracks that are extending from the holes.
4. Clean the prechamber gasket set in the cylinder head by using the 9U-5156 Cleaning Tool Group. Wipe the surface with a clean cloth and solvent.
5. Install new prechamber gaskets and O-rings.
6. Install the ignition body assembly in cylinder head. Refer to the engine's Specifications manual for the proper torque procedure.

i02602093

Prechamber Check Valves - Clean

SMCS Code: 1550-070

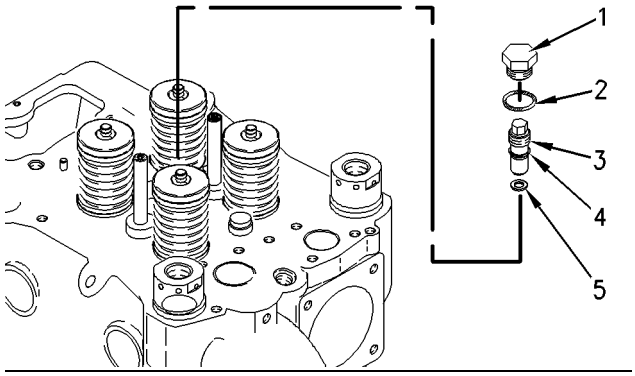


Illustration 100 g00789869

(1) Plug
(2) O-ring seal
(3) Check valve assembly
(4) O-ring seal
(5) Gasket

Note: Use of a platform may be necessary to reach the prechamber check valves.

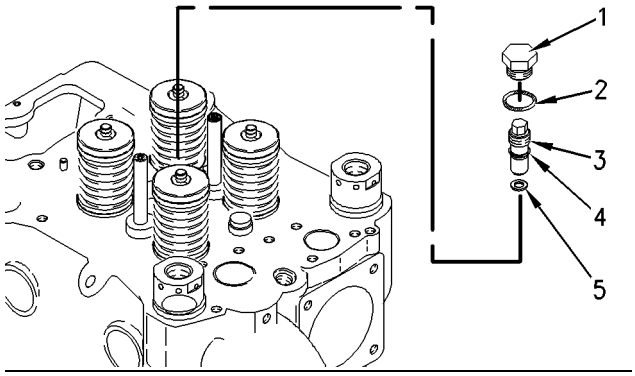
Note: Refer to the engine's Disassembly and Assembly manual for instructions on removal and installation of the check valves.

1. Remove check valve assembly (3) and gasket (5).
2. Discard gasket (5) and O-ring (4). Disassemble the check valve by unscrewing the end cap.
   a. Clean all parts with a non-chlorinated solvent.
   b. Reassemble the check valve and torque the cap to 2 N·m (1.5 lb ft).
3. Install a new gasket and a new O-ring. Install the clean, dry check valve assembly and torque to 115 N·m (85 lb ft).
4. Do NOT overtighten the plug for the check valve. Tighten to 15 N·m (11 lb ft).

i02602222

Prechamber Check Valves - Replace

SMCS Code: 1550-510



g00789869

Illustration 101

(1) Plug
(2) O-ring seal
(3) Check valve assembly
(4) O-ring seal
(5) Gasket

Note: Use of a platform may be necessary to reach the prechamber check valves.

Note: Refer to the engine's Disassembly and Assembly manual for instructions on removal and installation of the check valves.

1. Remove check valve assembly (3) and gasket (5).
2. Keep plug (1) for reassembly. Discard the other parts. Obtain new parts for reassembly.
3. Install a new gasket and a new O-ring. Install the clean, dry check valve assembly and torque to 115 N·m (85 lb ft).
4. Do NOT overtighten the plug for the check valve. Tighten to 15 N·m (11 lb ft).

i01612991

Prelube Pump - Inspect

SMCS Code: 1319-040

Inspect the prelube pump for the following conditions:

- Cracks
- Pin holes
- Proper operation
- Wear

Inspect the prelube pump for leaks. Replace all of the seals if a leak is observed.

Inspect the wiring for the following conditions:

- Damage
- Fraying

Ensure that the wiring is in good condition.

Inspect the electrical connections. Ensure that the electrical connections are secure.

If repair or replacement is necessary, refer to the engine's Disassembly and Assembly manual. Consult your Caterpillar dealer for assistance.

Air Prelube Pump

Inspect all of the components in the air circuit for the prelube pump. Inspect all of the air lines and connections for leaks. Ensure that the components in the air circuit are in good condition.

Electric Prelube Pump

Inspect the brushes. Replace the brushes, if necessary.

i01113939

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

If the starting motor fails, the engine may not start in an emergency situation. A scheduled inspection of the starting motor is recommended.

The starting motor pinion and the flywheel ring gear must be in good condition in order for the engine to start properly. The engine will not start if the starting motor pinion does not engage the flywheel ring gear. The teeth of the starting motor pinion and the flywheel ring gear can be damaged because of irregular engagement.

Inspect the starting motor for proper operation. Listen for grinding when the engine is started. Inspect the teeth of the starting motor pinion and the flywheel ring gear. Look for patterns of wear on the teeth. Look for teeth that are broken or chipped. If damaged teeth are found, the starting motor pinion and the flywheel ring gear must be replaced.

Electric Starting Motor

Note: Problems with the electric starting motor can be caused by the following conditions: malfunction of the solenoid and malfunction of the electric starting system.

Inspect the electrical system for the following conditions:

- Loose connections
- Corrosion
- Wires that are worn or frayed
- Cleanliness

Make repairs, if necessary.

Air Starting Motor

⚠ WARNING

Personal injury or death can result from improperly checking for a leak.

Always use a board or cardboard when checking for a leak. Escaping air or fluid under pressure, even a pin-hole size leak, can penetrate body tissue causing serious injury, and possible death.

If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

Inspect all of the components in the air circuit for the starting motor. Inspect all of the air lines and connections for leaks.

If the teeth of the starting motor pinion and/or the flywheel ring gear are damaged, the air circuit for the starting motor must be examined in order to determine the cause of the problem.

Removal and Installation of the Starting Motor

Refer to the Service Manual, “Disassembly and Assembly” module for information on removing the starting motor and installing the starting motor.

Consult your Caterpillar dealer for assistance.

i01765784

Turbocharger - Clean (Cleaning with Dry Particles)

SMCS Code: 1052-070

Note: Use of a platform may be necessary to reach the turbocharger.

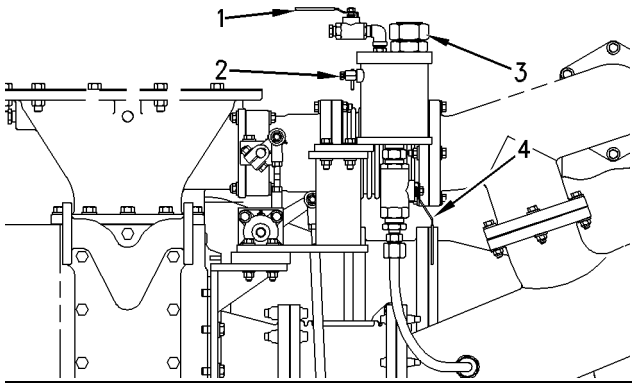
If the engine has more than one turbocharger, each turbocharger requires cleaning.

Note: The drain openings in the exhaust housing of the turbocharger are closed during the cleaning procedure. Some of the particles will be expelled through the exhaust stack. The particles that are expelled will be burned.

The materials that are listed in Table 43 are recommended for use with this cleaning procedure.

Table 43

Materials for Cleaning 3600 Engine Turbochargers	
Material	**Particle Size**
Nut shell	1.7 mm (1/16 inch)
Formed carbon	1 mm (1/32 inch)
Granulated carbon (70% hardness)	1.2 to 2 mm (3/64 to 5/64 inch)
Granulated dry rice	1.7 mm (1/16 inch)



g00833073

Illustration 102

(1) Air valve
(2) Purge valve
(3) Cap
(4) Gate valve

Note: During normal engine operation, air valve (1), purge valve (2), and gate valve (4) are closed.

1. Ensure that purge valve (2) is closed. Ensure that cap (3) is secure. Open gate valve (4).

2. Open air valve (1) in order to remove deposits that may be in the connecting pipe. After three minutes, close air valve (1). Close gate valve (4).

3. Open purge valve (2) in order to relieve any pressure from the container. Close purge valve (2).

4. Remove cap (3). Pour 0.5 L (0.5 qt) of the particles into the container. Tighten cap (3).

5. Ensure that purge valve (2) is closed. Reduce the output of the engine so that the exhaust temperature before the turbine is less than 577 °C (1070 °F).

6. Open gate valve (4). Open air valve (1).

7. After 60 to 90 seconds, close air valve (1). Close gate valve (4).

8. Open purge valve (2) in order to relieve any pressure from the container. Close purge valve (2).

i00908991

Turbocharger - Inspect

SMCS Code: 1052-040

Periodic inspection and cleaning is recommended for the turbocharger.

Fouling of the turbine wheels can contribute to loss of engine power and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel could allow parts from the compressor wheel to enter an engine cylinder. This can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require clearances that are precise. The turbocharger cartridge must be balanced due to high rpm.

The following conditions can cause the turbocharger to be out-of-balance:

- The buildup of deposits
- Chipping and/or flaking of deposits

If the turbocharger must be removed for inspection, use caution. Do not break deposits from the turbine wheel. Do not attempt to clean the turbine wheel. For options regarding removal, installation, repair and replacement, see the Service Manual or consult your Caterpillar dealer.

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

   The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

Note: Deposits of ash and silicon can accumulate on the turbine wheel. Turbine wheel will become unbalanced when the deposits flake off. The turbocharger cartridge must be replaced when this occurs. However, remove deposits from the housing. This will prevent wear on the blades of the turbine wheel.

4. Inspect the turbine wheel and the nozzle for deposits of ash and silicon. If deposits of 1 mm (1/32 inch) thickness are found, the turbocharger must be disassembled and cleaned at an ABBrepair facility.

5. Inspect the bore of the turbine housing for corrosion.

6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

7. Check the clearances of the turbocharger bearing. Compare the clearances to the Service Manual, “Specifications”. If the clearances are not within the specifications, the turbocharger must be repaired.

8. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

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Turbocharger Cleaner Tube - Replace

SMCS Code: 1052-510

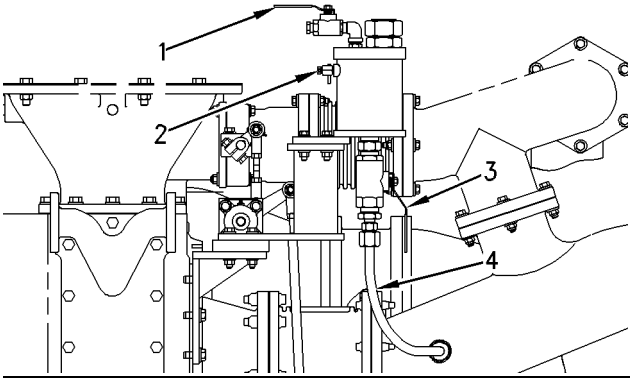

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Illustration 103

(1) Air valve
(2) Purge valve
(3) Gate valve
(4) Tube

Note: Use of a platform may be necessary in order to reach the cleaner tube.

1. Stop the engine.

2. Ensure that air valve (1) and gate valve (3) are closed.

3. Open purge valve (2) in order to relieve any pressure from the container.

4. Remove tube (4). Discard the used tube.

5. Install a new tube.

6. Close purge valve (2).

i00682053

Valve Stem Projection - Measure/Record

SMCS Code: 1105-082

Valve Recession – The valves and the valve seats are worn over time. This causes the valves to recede into the cylinder head. This condition is called “valve recession”.

The exhaust valves and valve seats show the greatest wear due to high operating temperatures. The top end overhaul interval is normally scheduled according to exhaust valve recession.

The actual measurement of the valve recession inside of the cylinder head is difficult to obtain. Two simpler methods are used to determine valve recession:

- Measure the projection of the valve stem above the cylinder head. It is necessary to remove the rocker arms in order to obtain this measurement. This method is more accurate than measuring the projection of the exhaust valve rotators. Measure the projection of the exhaust valve stems with the 4C-2980 Cylinder Head Valve Projection Group.
- Measure the projection of the valve rotator above the cylinder head. It is not necessary to remove the rocker arms in order to obtain this measurement. Measure the projection of the exhaust valve rotators with the 148-2997 Valve Recession Tool Group.

Make several copies of this Operation and Maintenance Manual, “Valve Data Sheet” (Reference Materials Section). Record the measurements on the sheets.

- Measure the projection of the inlet and exhaust valve stems and the exhaust valve rotators at the first 1000 service hours. This measurement is the baseline. The baseline is a reference for subsequent measurements.
- Measure the projection of the inlet and exhaust valve rotators when the engine valve lash is checked. Continue this periodic measurement until the projection of the valve rotator has increased by a total of 1.6 mm (.063 inch). This is 70 percent of the maximum limit. Measure the projection of the valve stems when this occurs. This measurement will determine the actual wear of both the valves and the valve seats.
- After 70 percent of the maximum limit has been reached, measure the projection of the exhaust valve stems at every 500 hours of operation.
- Plan for the top end overhaul as the valve stem projection approaches the maximum limit. Perform the top end overhaul when the valve stem projection has increased by a total of 2.3 mm (.09 inch). **Do not allow the valve recession to exceed this limit.** The valve head can break. This will cause severe damage in the combustion chamber and the turbocharger.

Consult your Caterpillar dealer for assistance.

i01492446

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, thoroughly inspect the engine room before starting the engine. Look for items such as leaks, loose bolts, loose connections and trash buildup. Make repairs, as needed.

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE
For any type of leak, clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE
Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur when the engine cools and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For instructions on removal and installation of water pumps and/or seals, refer to the Service Manual, “Disassembly and Assembly” module for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve covers.

⚠ WARNING

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

- Check the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground straps for good connections and for good condition.
- Check the condition of the gauges. Replace any gauge that is damaged. Replace any gauge that can not be calibrated.
- Inspect the exhaust system for leaks. If a leak is found, make repairs.

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Water Pump - Inspect

SMCS Code: 1361-040

A failed water pump might cause severe engine overheating problems that could result in cracks in the cylinder head, a piston seizure or other potential damage to the engine.

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Disassemble and Water Pump - Assemble” for the disassembly and assembly procedure. If it is necessary to remove the water pump, refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Remove and Water Pump - Install”.

Inspect the water pump for wear, cracks, pin holes and proper operation. Refer to the Parts Manual for the correct part numbers for your engine or consult your Caterpillar dealer if repair is needed or replacement is needed.